

Issued November 6, 1914.

U. S. DEPARTMENT OF AGRICULTURE.

BUREAU OF SOILS—MILTON WHITNEY, Chief.

IN COOPERATION WITH THE PENNSYLVANIA STATE COLLEGE
SCHOOL OF AGRICULTURE AND EXPERIMENT STATION;
THOMAS F. HUNT, DEAN AND DIRECTOR.

RECONNOISSANCE SOIL SURVEY OF SOUTHEASTERN PENNSYLVANIA.

BY

CHARLES F. SHAW, OF THE U. S. DEPARTMENT OF AGRICUL-
TURE, AND J. M. MCKEE AND W. G. ROSS, OF THE
PENNSYLVANIA STATE COLLEGE.

[Advance Sheets—Field Operations of the Bureau of Soils, 1912.]



WASHINGTON:
GOVERNMENT PRINTING OFFICE.
1914.

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SOIL SURVEY.

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J. W. MCKERCHER, *Secretary.*

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LETTER OF TRANSMITTAL.

UNITED STATES DEPARTMENT OF AGRICULTURE,
BUREAU OF SOILS,
Washington, D. C., February 21, 1914.

SIR: In continuation of the soil survey work in Pennsylvania a reconnaissance survey of the southeastern part of the State was made during the field season of 1912. The work was done in cooperation with the State College of Agriculture and Experiment Station, and the selection of this area was made after conference with the state officials.

I have the honor to recommend that the accompanying manuscript report and map covering this survey be published as advance sheets of Field Operations of the Bureau of Soils for 1912, as authorized by law.

Respectfully,

MILTON WHITNEY,
Chief of Bureau.

Hon. D. F. HOUSTON,
Secretary of Agriculture.

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MAP.

Soil map, reconnaissance survey, southeastern Pennsylvania sheet.

RECONNOISSANCE SOIL SURVEY OF SOUTHEASTERN PENNSYLVANIA.

By CHARLES F. SHAW, of the U. S. Department of Agriculture, and J. M. MCKEE and W. G. ROSS, of the Pennsylvania State College.

GENERAL DESCRIPTION OF THE AREA.

The area surveyed covers the 19 counties of southeastern Pennsylvania, including Northumberland, Montour, Columbia, Luzerne, Monroe, Carbon, Schuylkill, Dauphin, Lebanon, Berks, Lehigh, Northampton, Bucks, Montgomery, Philadelphia, Delaware, Ches-

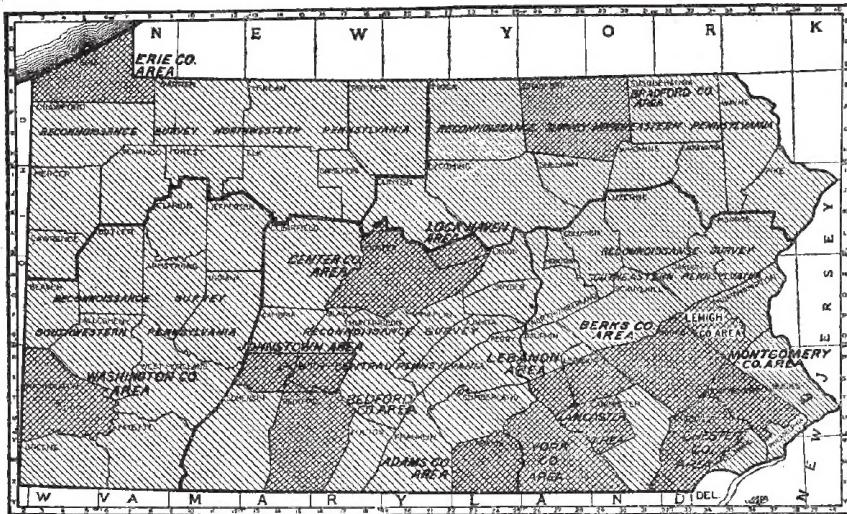


FIG. 1.—Sketch map showing areas surveyed in Pennsylvania.

ter, Lancaster, and York, with a total area of 10,254 square miles, or 6,562,560 acres. Of these 19 counties, detailed maps had been made of Chester, Montgomery, Berks, and parts of Lebanon and Lancaster Counties. These maps and reports were used in the present work where it was possible, considerable revision being necessary on the older maps to bring the correlations up to date. Lehigh and York Counties were being surveyed in detail during the prosecution of the present survey, and the data thus secured were also used in the present map and report. This area completes the reconnois-

sance map of Pennsylvania. It joins the Northeast Pennsylvania Reconnoissance (1911) on the north and the South-Central (1910) on the west. Maryland and Delaware lie to the south and New Jersey to the east of the area.

The area is one of widely differing topographies and geological formations. In the southeast, along the Delaware River, from Trenton to the Delaware boundary, lies a narrow strip of Coastal Plain country, ranging from 3 to 6 miles in width, with a level or gently sloping surface. Passing inland from this one comes first to the Piedmont Plateau region, varying from the general condition of gently rolling topography, with the entire surface in farms, to rough hilly areas, where the land is in forest or pasture. Breaking the Piedmont region, and bounding it on the north, lie the fertile limestone valleys with their gently rolling topography, depressed somewhat below the general level of the country. Of these the Lancaster Valley, covering a large area in Lancaster and York Counties, and the Great Valley, an extension of the Cumberland Valley, which crosses Dauphin, Lebanon, Berks, Lehigh, and Northampton Counties, are most extensive. Chester Valley and other smaller valleys lie south of the larger ones, each a fertile rolling expanse of fine farm land surrounded by elevated hilly lands.

North of the Great Valley lies Blue or First Mountain, an effective barrier rising over 1,000 feet above the valleys, or to an altitude of 1,200 to 1,500 feet above sea level, and cut through only by the Delaware, Lehigh, and Susquehanna Rivers and Swatara Creek. Beyond this mountain front lie other paralleling mountain ranges, inclosing hilly valleys of sandstone and shale, the most important and fertile being those known as the "red shell" valleys. Of these, Lykens Valley and Cherry Valley are the largest and best developed. The greater part of the area lying north of Blue Mountain is rough mountain land, not suited to agriculture, but well adapted to forestry. Most of the farmed lands lie in the shale valleys and in small areas on the sandstones near the coal-mining towns.

The northern and northeastern parts of the area have been glaciated. The Terminal Moraine enters Columbia County near the northwest corner, cuts across the eastern side of that county, crosses northern Luzerne, northern Carbon, northern Monroe, and northeastern Northampton Counties, and extends thence beyond the Delaware River into New Jersey near Belvidere. A large part of the glacial area is rough and mountainous; about one-third is rolling to hilly and can be farmed. The tendency of the glacial action was to make the general topographic features less rugged and severe, but the load of till carried by the ice was so slight that in many cases the evidence of glacial action is very obscure.

DRAINAGE.

The whole region covered by the survey drains into the Delaware and Susquehanna Rivers. The larger area is tributary to the Delaware, either directly or through the Lehigh and the Schuylkill Rivers. The Delaware forms the eastern boundary of the area and receives the drainage from the eastern row of counties through small creeks and streams. The Lehigh River drains all of Carbon County, parts of Monroe, Luzerne, and Schuylkill, and most of Lehigh and Northampton Counties. The Schuylkill rises in the county of that name and, through several large tributaries, cares for the drainage of Schuylkill, Berks, Montgomery, Chester, Bucks, Delaware, and Philadelphia Counties. The Susquehanna River receives the run-off from the northern and western counties of the area, large tributary streams carrying the drainage through the valleys to the river. Of these Fishing, Shamokin, Catawissa, Swatara, Wiconisco, and Conestoga Creeks are the largest, though there are many other smaller streams. None of the streams have built extensive flood plains. Some extensive areas of bottom and terrace lands are found along the lower Susquehanna, but as a whole the rivers and creeks are geologically young, with narrow valleys and small areas of alluvial sediments along their courses. The Schuylkill has been rendered navigable by the construction of dams and by canals and locks around the rapids. Considerable coal is transported by barges from the mines to the seaboard by this water route. The Delaware is navigable to Trenton, but the Susquehanna is not used for transportation, the old canal along its course having been abandoned for many years.

The whole area is well drained, there being little or no land that is in a swampy condition. Under ordinary conditions drainage systems are capable of caring for the run-off of the region, though in times of abnormal rainfall severe floods often occur, especially along the Susquehanna and its tributaries.

POPULATION.

The population of this area, as given by the census of 1910, is 3,752,741, an increase of 619,231, or 19.76 per cent, over the figures of 1900. The rural population¹ has increased from 973,174 in 1900 to 1,064,456 in 1910, a gain of 91,282, or 9.38 per cent, in 10 years. The population has increased in every county except one, Montour, which shows a loss of 4.2 per cent in total population and 1.8 in rural population. The gain in population has been most rapid in the cities, though three counties, Delaware, Northumberland, and Montgomery, show a gain in rural population of over 20 per cent in the 10 years.

¹ Population outside of incorporated places of 2,500 inhabitants or more. (Thirteenth Census.)

The following table shows the total population and rural population of each county, together with the percentage increase in each:

Total and rural population of the counties covered in the present survey.

County.	Population.		Per cent increase.	Rural population.		Per cent increase.
	1910	1900		1910	1900	
Berks.....	183,222	159,615	14.8	84,221	78,390	17.4
Bucks.....	76,530	71,190	7.5	57,390	56,235	2.1
Carbon.....	52,846	44,510	18.7	24,999	22,049	13.4
Chester.....	109,213	95,695	14.1	66,891	64,767	3.3
Columbia.....	48,467	39,896	21.5	30,185	29,810	1.3
Dauphin.....	136,152	114,443	19.0	46,499	40,886	13.7
Delaware.....	117,906	94,762	24.4	62,281	49,310	26.3
Lancaster.....	167,029	159,241	4.9	102,569	101,542	1.0
Lebanon.....	59,565	53,827	10.7	40,325	36,199	11.4
Lehigh.....	118,832	93,893	26.6	46,572	44,227	5.3
Luzerne.....	243,186	257,121	33.5	109,951	100,246	9.7
Monroe.....	22,941	21,161	8.4	15,232	15,063	1.1
Montgomery.....	169,590	138,995	22.0	102,535	84,839	20.9
Montour.....	14,368	15,526	-4.2	7,351	7,484	-1.8
Northampton.....	127,667	99,687	28.1	48,763	44,721	9.0
Northumberland.....	111,420	90,911	22.6	49,553	40,797	21.5
Philadelphia.....	1,549,008	1,293,697	19.7	.....	.....	.....
Schuylkill.....	207,894	172,927	20.2	84,541	79,206	8.7
York.....	136,405	116,413	17.2	84,598	77,403	9.3
Total.....	3,752,741	3,133,510	19.76	1,064,456	973,174	9.38

The large cities have made a very rapid growth during the last decade. The largest city in the area is Philadelphia, with a population of 1,549,008. Nearly 55 per cent of the inhabitants of the area surveyed live in towns of 25,000 or more. The statistics for the cities in the area with a population of over 25,000 are shown in the following table:

Population of cities in the area having more than 25,000 inhabitants.

City.	Popula- tion.	Increase over pre- ceding census.		City.	Popula- tion.	Increase over pre- ceding census.	
		Number.	Per cent.			Number.	Per cent.
Allentown.....	51,913	16,497	46.0	Philadelphia.....	1,549,008	255,311	19.7
Chester.....	38,537	4,549	13.4	Reading.....	96,071	17,110	21.7
Easton.....	28,523	3,285	13.0	Wilkes-Barre.....	67,105	15,384	29.7
Harrisburg.....	64,186	14,109	27.9	York.....	44,750	11,042	32.8
Hazleton.....	25,452	11,222	78.9	Total.....	2,040,629	.....	.....
Lancaster.....	47,227	5,767	13.9				
Norristown.....	27,857	5,610	25.2				

Of the total population, over 18 per cent is foreign born. Most of these are employed in the mines and mills. About two-thirds of the

foreign-born inhabitants are Slavic, the remainder being to a greater extent from the Latin races. Not over 25 per cent of the total population is engaged in farming operations. This fact, together with the fertile soil and ready markets, makes the region one of great promise for the future of agriculture. The farming population is of mixed parentage. In the limestone valleys the so-called "Pennsylvania Dutch" are found, almost to the exclusion of the other races. The Germans are also numerous in the valleys of Upshur soils.¹ On the Chester soils the descendants of the English and the Scotch-Irish settlers are most numerous, while in other sections the farming population is of that mixed derivation best described as "American." The agricultural population is industrious and progressive, and southeastern Pennsylvania is one of the leading agricultural sections of the country.

HISTORY AND DEVELOPMENT.

The portions of the area surveyed lying south of Blue Mountain were part of the original lands granted to William Penn by King Charles or purchased by Penn from the Indians who then inhabited the region. These grants and purchases date from 1680 to 1697 or later, the purchases being made from time to time as the number of settlers increased and the encroachment on the Indian lands became greater.

The liberal religious views held by the governors of the Penn colonies attracted many sects and nationalities to the region. Besides the original Penn settlements of Quakers, or Friends, at Philadelphia and Chester about 1682 there were settlements by Swedes in Berks County, Germans near Germantown, and Welsh in northern Montgomery County. In 1709 Mennonites from Germany and Switzerland settled in Lancaster County, in 1715 French Huguenots came from Alsace-Lorraine, and in 1720 Scotch-Irish settled in southern Lancaster County. From this time on the progress of this region was rapid. The Scotch-Irish settled on the rolling lands, while the Germans and Swedes cleared the limestone valleys.

In the northern part of the area surveyed trappers and traders had established posts prior to 1750, but the first permanent settlements were not established until about 1770. Indian troubles, and the difficulties between the Penn colonies and Connecticut colonies, which culminated in the "Pennamite" wars, retarded the development of the region, and it did not become well settled until after the Revolutionary War. The settlers came in two streams, one from the south, the Penn colonies, and one from the east, the New Amsterdam and Connecticut colonies. The former were of the various races that were settling in the colonies to the south, and the latter were mostly Anglo-Saxons.

¹ The local name for these soils is "red shell land."

The settlers found the whole region covered with a dense forest growth, broken only by the rare "glades" and the old Indian fields. In clearing the land the logs were burned, there being no market for lumber. Near Philadelphia, as that town grew, some wood was sold for firewood and some timber cut and used in building.

Corn, oats, barley, buckwheat, flax, and hemp were the first crops grown. Spelt was grown in Lancaster County in the earlier settlements, but wheat soon became an important crop. Most of the settlements were self-sustaining, the trade being largely confined to furs and pelts, whisky, and similar compact, nonperishable products.

With the establishment of the Government roads across the State to the western colonies came better transportation and the need of oats and hay for the draft horses and meat and drink for the teamsters. The Lancaster pike, the first macadam road in the country, was built in 1794 and formed the east end of the Philadelphia-Pittsburgh pike. Grist mills and flour mills were built on the streams, and more of the grain products found their way to the coast markets as flour and feed. Orchards of apples, pears, plums, and other fruit were set out by the colonists.

The presence of coal in the mountains of Schuylkill, Carbon, Luzerne, and the other northern counties has had a marked influence on the development of those regions. Coal was "discovered" at Mauch Chunk in 1790, but was not used for many years. In 1808 it was successfully burned in a grate in Wilkes-Barre, and shortly afterwards an ironmaster of Philadelphia used it with great success in his furnaces. When the value of coal became apparent, transportation lines were opened into the region. The first coal was carried by boat from the Wilkes-Barre district down the Susquehanna to Columbia and Baltimore. In 1825 the Schuylkill coal field was recognized and began to be developed. The development of the Schuylkill River by slack-water navigation was started soon after and railroads were built into the region. The Lehigh Valley Railroad was started in 1839 and was completed to Wilkes-Barre in 1867. The Philadelphia & Reading Railway was started in 1835 as the Philadelphia, Germantown & Norristown. These roads, with the canals and wagon roads, served to open the northern counties.

Wagon roads were well developed in the southern counties by this time, and the present Pennsylvania Railroad was started by the building of a line from Philadelphia to Columbia. This line at first used horsepower, but soon after opening began to use steam locomotives. This road, with a system of canals along the Susquehanna and Juniata Rivers, connected Philadelphia with the Wilkes-Barre anthracite coal region and the Pittsburgh bituminous coal region. The canal systems did not prove a success, and the Pennsylvania Railroad was constructed, being opened through to Pittsburgh in 1852.

At the present time the area is well supplied with transportation lines. The Pennsylvania main lines cross the southern counties from Philadelphia to Harrisburg and from Trenton through Philadelphia into Delaware. The Northern Central crosses York County and follows the western boundary, while other leased or branch lines of the Pennsylvania system tap the coal fields of the Schuylkill and Wilkes-Barre regions, as well as the agricultural counties to the south. The Philadelphia & Reading System lies almost wholly in the region surveyed, the main line and various branches spreading over most of the area. The Lehigh Valley, Central of New Jersey, and Delaware, Lackawanna & Western Railroads cross the northern and northeastern counties and give excellent connection with New York. Interurban electric roads intersect all parts of the counties south of Blue Mountain, and several important electric lines serve the northern counties. There are a few valleys of high agricultural value that are at present lacking suitable transportation facilities, but in some cases these have already been projected. With the steam and electric lines nearly every part of the area is six hours or less from Philadelphia or New York, with the constant food demands of their millions of people.

Coal is the greatest natural resource and coal mining overshadows all other industries. Besides coal, however, there are several other valuable natural products. Slate quarries are numerous in Northampton County, the best quality of slate for roofing and industrial uses being found. Clay products, brick, tile, and terra-cotta works are found in some counties, while limestone is a valuable product that is extensively used, quarries and kilns being numerous, especially in Lancaster, Lebanon, Dauphin, and Berks Counties.

The region once supported a magnificent growth of forest, pines and oaks predominating. On most of the area these forests were cut away and destroyed long before the demand for lumber made them of value. The forests in the mountainous regions were cut over at an early date and used in timbering the mines and for fuel at the kilns and furnaces. There are some well forested areas at the present time, but most of the rough land that is especially adapted to forest growth is in stumps and brush and is subject to the frequent fires so destructive to young growth. There is opportunity for extensive reforestation work, and it is hoped that the state forest lands can be handled to advantage in securing a covering of valuable woods.

With over two-thirds of the population engaged in mining, manufacturing, or industrial pursuits and with the excellent transportation facilities, the markets for agricultural products are the best. Corn, wheat, oats, rye, potatoes, buckwheat, hay, tobacco, fruit, and vegetables find a ready sale and with the high per acre yields on the better soils prove very profitable. The mines and cities afford constant markets for hay, oats, and other feeds for horses and mules, while the demands of the cities for dairy products, vegetables, and

fruit are growing constantly. The opportunity for intensive agriculture, for growing special crops of high quality and selling under trademark to special custom is marked, especially with regard to the three classes of products mentioned—dairy, vegetables, and fruit. There are over 10,000,000 people within less than 10 hours by rail. With this location markets for the agricultural products of the region are assured.

CLIMATE.

Two types of climate are found in the region covered by this survey—the "marine" type in the southeastern part and the "mountain" type in the central and northern parts. The range of temperature is much narrower in the southern section than in the mountain section. The summer mean for the southern counties is about 73° and the winter mean is about 31° , while in the mountain counties the means are about 87° and 25° . Temperatures of 100° or over are rarely recorded in the area, but in the southern section the high humidity makes the heat of summer quite oppressive. The summer climate in the mountain regions is delightful, and there are many noted summer resorts and sanatoriums in the mountains of this section of Pennsylvania. In the southern counties the winters are mild, the total snowfall being less than 30 inches, and rarely staying on the ground for any length of time. In the northern counties the winters are much colder, with minimum temperatures of -12° to -20° . Snowfall is moderately heavy, averaging about 40 inches.

The average annual precipitation is about 43 inches and is well distributed throughout the year, the heaviest rainfall occurring during the summer months. Though the monthly precipitation is highest in June, July, and August, short droughts are of frequent occurrence during these months, the total rainfall often coming during one or two severe storms. These very heavy local rains, frequently torrential in character, cause considerable damage to crops, as well as occasioning severe erosion in the cultivated fields.

The growing season is long, averaging over 150 days between the last frost of spring, about May 1, and the first in the fall, about the middle of October. In the mountain valleys the growing season is often shorter, with severe frosts occurring as early as September and as late as June. The prevailing winds are westerly, generally from the northwest in winter and the southwest in summer. The winds are generally light to moderate, with occasional cyclonic winds in the southern counties.

The following tables give the mean monthly, seasonal, and annual temperatures and precipitations at Mauch Chunk, elevation 634 feet, and Philadelphia, elevation 90 feet:

Normal monthly, seasonal, and annual temperature and precipitation.

AT MAUCH CHUNK.

Month.	Temperature.			Precipitation.			
	Mean.	Absolute maximum.	Absolute minimum.	Mean.	Total amount for the driest year.	Total amount for the wettest year.	Snow, average depth.
December.....	30.3	65	- 5	4.22	5.72	7.90	7.8
January.....	27.1	66	-13	3.75	5.06	4.54	11.0
February.....	26.5	67	-14	4.13	2.02	7.16	12.6
Winter.....	28.0	.....	.....	12.10	12.80	19.60	31.4
March.....	36.6	86	- 9	4.76	2.53	4.89	8.7
April.....	48.4	92	14	3.36	6.32	5.45	1.8
May.....	60.3	97	26	4.41	2.98	.59	.....
Spring.....	48.4	.....	.....	12.53	11.83	10.93	10.5
June.....	68.5	99	38	4.14	1.74	8.93	.....
July.....	72.5	104	41	4.99	5.41	6.64	.....
August.....	70.3	99	36	4.73	2.12	3.64	.....
Summer.....	70.4	.....	.....	13.86	9.27	19.21	.....
September.....	64.4	97	28	4.02	1.27	7.90	.....
October.....	51.5	91	20	3.97	2.80	5.85	Trace.
November.....	40.4	74	5	3.49	3.00	1.56	3.2
Fall.....	52.1	.....	.....	11.48	7.07	15.31	3.2
Year.....	49.7	104	-14	49.97	40.97	65.05	45.1

AT PHILADELPHIA.

December.....	35.7	69	- 5	3.07	2.63	1.38	4.0
January.....	31.8	72	- 5	3.23	3.66	5.84	6.5
February.....	32.8	75	- 6	3.35	4.76	4.75	8.3
Winter.....	33.4	.....	.....	9.65	11.05	11.97	18.8
March.....	40.0	86	5	3.43	3.83	2.05	4.0
April.....	50.8	93	18	2.92	.61	3.51	.3
May.....	62.2	96	34	3.30	2.71	5.83	.....
Spring.....	51.0	.....	.....	9.65	7.15	11.39	4.3
June.....	71.2	98	46	3.27	3.87	.90	.....
July.....	75.8	103	54	4.14	.96	5.00	.....
August.....	73.8	101	51	4.69	1.18	11.49	.....
Summer.....	73.6	.....	.....	12.10	6.01	17.39	.....
September.....	67.4	102	40	3.36	.94	3.63	.....
October.....	56.3	88	31	3.01	3.04	5.80	Trace.
November.....	44.9	77	8	3.11	2.02	5.10	.9
Fall.....	56.2	.....	.....	9.48	6.00	14.53	.9
Year.....	53.6	103	6	40.88	30.21	55.28	24.0

AGRICULTURE.

The area surveyed consists of four divisions, the rolling to hilly lands of the Piedmont and Coastal Plain regions, the level to rolling limestone valleys, the moderately hilly shale valleys, and the hilly and mountainous plateaus and mountain ranges. The first two divisions constitute the best agricultural lands and cover all of the counties south of Blue Mountain. North of this barrier lie the steep, stony mountain ridges, inclosing the shale valleys, and elevated, plateau-like uplands. The agricultural conditions of these divisions differ considerably in crops produced, in agricultural practice, and in returns from the farming operations.

In the Coastal Plain region, a band from 2 to 6 miles wide along the Delaware River, from Trenton to the southern boundary of the State, the soils are well adapted to the production of truck and garden crops and to the general farm crops. A large part of this region is occupied by city or suburban developments, and nearly all of it is held at prices higher than the agricultural value, prices being influenced by the location and suitability of the land for suburban residences or manufacturing sites. There are many truck farms and market gardens in this region, the industry being very highly developed in the vicinity of Philadelphia. These gardens are very intensively handled, intercropping being regularly practiced and two or more crops gotten each season. Fertilizers and manures are used in large quantities, over 100 tons of manure per acre being applied in many cases. The returns from these gardens are high and the industry is a profitable one.

On much of the land the general farm crops are grown, dairying being the principal industry. This is especially true on the land that is farmed by tenants, the landowner hoping ultimately to sell for subdivision. On many of these dairy farms the land is poorly handled, little fertilizer is used, and often the manure is not properly cared for and applied to the fields. The tenants operate on annual leases and, knowing that their stay may be very short, do not attempt to build up the soil, but make all the profit they can without thought for the future. They can hardly be blamed for this attitude, nor can the owners be expected to spend much in building up the fertility of lands that they hope to sell for residential purposes.

This same condition holds good on some of the Piedmont soils adjacent to Philadelphia and along the main transportation lines. On the main line of the Pennsylvania Railroad west of Philadelphia are farms worth from \$500 to \$2,000 per acre that are either lying idle or are farmed in slipshod manner by tenants who, in some cases, do not even have an annual lease, but are subject to eviction at any

time should the farm be sold. In sharp contrast to these farms are the country estates of wealthy men, with their magnificent buildings and well-kept fields. This immediate region is scarcely to be considered a farming region, but is rather a region of country estates and residences.

These conditions prevail only in the region immediately in contact with Philadelphia, the greater part of the Piedmont Plateau being a highly developed farming section.

The Piedmont Plateau soils fall in two classes—those from the igneous and metamorphic rocks, principally the Chester and Manor soils, and those from sandstones and shales, the Penn and Lansdale soils. All of these soils are of high fertility and the farms are among the most successful in the State. Over the whole region corn, oats, wheat, and grass are the principal crops, with potatoes a very important crop on many farms. Dairying is the principal industry, milk and cream being shipped to Philadelphia and the other large cities. Most of the corn and hay produced are fed on the farms, only the excess over that needed by the dairy herds or work animals being sold. Some alfalfa is grown, good results being obtained. On the Chester soils are located several nurseries and some commercial orchards. Some seed farms and florists are also found on these soils. On the Penn and Lansdale soils potatoes are extensively grown and some large plantings of apples are being made. These soils seem well adapted to fruit where well drained.

The limestone valleys, with their gently rolling topography, good roads, and productive soils, are sections of fine farms, with substantial buildings and very neatly kept fields. They are the most productive areas in the State. The soils, which fall almost wholly into the Hagerstown series, are well adapted to the grain crops, grass, alfalfa, and tobacco. On most of the farms the standard rotation of corn, oats, wheat, and grass is followed, with many modifications to suit local conditions. Wheat is an important money crop. In Lancaster, York, and Lebanon Counties tobacco is a most important crop, a fine quality of filler leaf being grown. On many farms in these counties and on the limestone soils of the other counties, dairying is a very important industry, the milk being shipped to the cities or sold to creameries. The chocolate factory at Hershey has been an important factor in the development of dairying in its vicinity.

On the mountain plateau land of central Schuykill, northern Carbon, and Monroe, and southern Luzerne Counties there is little farming done. Most of this region is a dissected plateau, with shallow stony or gravelly lands, derived from the disintegration of sandstones and conglomerates, or from this material mixed with a small amount of glacial till. Most of this region is covered with brush, stumps, and

scattered trees—the remains of the former excellent forests. Near Hazleton and White Haven are a few small farms, and there are some scattered tilled areas near the lakes in northern Monroe County. In the latter county there are several areas where fruit and truck could be successfully grown, but most of the plateau region is best suited to forestry.

Between the many mountain ranges north of Blue Mountain lie rolling to hilly valleys in which the soils are derived mainly from shales. Those with the red Upshur soils are generally broader and of higher productivity than those with the yellowish Dekalb soils. Lykens Valley and Cherry Valley are two broad, rolling areas of productive Upshur soils. Dairying and grain farming are the leading industries. In the eastern part of the section considerable interest is being taken in apple growing, and some large orchards are being set out. Fruit does well on these soils.

On the narrower valleys of Dekalb soils general farming is the rule, though dairying and stock raising form an important part of the farm activities. The soils are adapted to fruit, potatoes, and the general farm crops and with proper tillage and the maintenance of humus can be made quite productive.

In northern Northumberland, Montour, and Columbia Counties, are broad regions of rolling Dekalb soils, and east of Fishing Creek, in Columbia and Luzerne Counties, are found Volusia soils on similar topography. In these regions general farming is the rule, with considerable areas devoted to the production of potatoes, and with many large dairies. The soils are well adapted to apples, and, in some localities, to peaches. Considerable trucking is done in Luzerne County, both on the uplands and on the bottom lands along the rivers.

The standard rotation over the whole area surveyed is corn, oats, and wheat, followed by grass for two or three years. In the mountain counties and on the glaciated soils rye is sown in place of wheat as the winter grain. Buckwheat, potatoes, and tobacco are important crops, but have no fixed place in the general farm rotation. Tobacco may take a regular place in a rotation, but is most often grown for a series of years in the same field and then transferred to another field. Buckwheat is sowed whenever another crop, such as corn, fails, or when it seems necessary or desirable to sow a crop rather late in the season. Where regularly grown it may follow or precede oats in the rotation. Potatoes are not grown extensively except in Lehigh and Northampton Counties, though there are large acreages in Chester, Lancaster, and Berks Counties. The rotation of potatoes, wheat, and clover is followed to some extent, though usually a rotation of corn, potatoes, oats, wheat or rye, and grass is preferred.

The following table shows the areas devoted to each of the leading crops by counties and for the section as a whole:

Acreages by counties of the leading crops grown in the area.

[Thirteenth Census.]

	Corn.	Oats.	Wheat.	Buck-wheat.	Rye.	Pota-toes.	To-bacco.	Hay.	Al-falfa.
Philadelphia.....	3,607	248	1,142	.....	726	1,540	.....	5,420	6
Delaware.....	9,525	1,584	5,508	.....	377	2,436	.....	16,314	31
Bucks.....	47,969	23,630	28,077	1,050	13,752	8,745	2	88,657	100
Montgomery.....	36,376	16,993	21,653	42	10,366	5,643	5	65,106	248
Chester.....	49,865	22,253	40,581	74	1,514	10,737	400	90,552	365
Northampton.....	25,148	21,003	26,441	1,228	16,810	5,264	.....	32,765	38
Lehigh.....	23,261	17,352	28,995	307	15,248	12,026	.....	37,305	86
Berks.....	57,563	46,269	67,719	158	18,294	10,675	216	98,770	266
Lancaster.....	80,825	20,098	115,568	33	3,583	12,654	32,783	109,384	544
Lebanon.....	24,485	19,751	33,053	4	1,966	2,966	416	40,070	292
Dauphin.....	27,820	22,507	27,285	207	3,300	3,160	104	45,499	385
York.....	78,597	26,528	83,920	714	12,342	10,841	6,134	92,463	161
Schuylkill.....	14,855	14,911	11,253	1,563	12,862	7,694	.....	35,711	57
Northumberland.....	24,793	22,715	26,401	3,186	5,976	4,395	15	32,246	63
Montour.....	10,201	9,374	10,194	1,847	1,627	864	.....	12,910	57
Columbia.....	23,574	21,063	20,061	10,048	11,115	3,992	.....	26,982	28
Carbon.....	3,993	4,574	1,336	1,650	5,340	1,854	.....	8,956	13
Luzerne.....	11,762	11,112	3,474	8,326	9,248	5,833	.....	31,003	3
Monroe.....	9,387	7,567	1,444	5,893	10,155	2,394	.....	17,883	2
Total for area.....	563,511	329,607	554,105	34,330	154,601	133,713	40,165	888,086	2,745

Corn is everywhere an important farm crop. The yields vary greatly over the area and are stated for the several soils and for the different sections of the area in the detailed type descriptions given in subsequent pages. Yields of 60 to 70 bushels per acre are generally considered good. Practically all the corn grown is of the yellow or white dent varieties. Chester County corn has won the National sweepstakes and other high honors at several of the National corn shows. Most of the corn grown is fed on the farms, only the surplus being sold. The stalks are also fed, being used as roughage for animals that are being "wintered over."

Wheat is grown very generally over the whole area. Yields vary greatly, averaging highest on the Hagerstown soils in the limestone valleys, where an average of 30 bushels or more is obtained in favorable seasons on the better farms. Wheat is displaced by rye in some sections, notably in northern Bucks County and in the northern counties. Very little wheat is grown in Monroe County or in Luzerne County outside of the Conyngham Valley. In some sections of the southern counties wheat is a very important crop, a larger acreage in many cases being devoted to wheat than to corn, wheat following wheat in the rotation. The good yields obtained, together with the demand for straw, makes it an important part of the rotation.

Oats are grown on most farms, generally following corn. The yields vary greatly, generally being below 50 bushels per acre. The crop is rarely fertilized.

Buckwheat, as has been pointed out, has no fixed place in the rotation. It is grown extensively in all the regions except in the limestone valleys. The crop is variable in its returns, the yields depending to a large extent on the season and the time of sowing. A yield of 20 bushels per acre is generally counted good. Some of the grain is fed, but most of it is sold to mills and manufactured into flour. The straw makes good roughage.

Potatoes are grown on nearly every farm in the area, but only on the Berks soils of Northampton and Lehigh Counties and in some regions on the Chester soils is this crop an important step in the rotations or item in the farm income. Usually the area devoted to potatoes is from one-half acre to 3 acres per farm—enough for home use and to supply the demands of the local market. In Chester County, on the Chester loam, and in many farms on the Berks soils in the two counties named above potatoes form an important part of the farm products. It is on these latter farms that the rotation of potatoes, wheat, and grass is used. Potatoes are shipped from these regions to Philadelphia, New York, and the towns in the eastern part of the State. The yields are good, 150 to 200 bushels or more being usually obtained by those who carefully fertilize and till their crops. Blight often causes considerable losses, and is not carefully guarded against. The best farmers spray regularly with Bordeaux, but most of the growers do not spray at all, or else wait until the damage from blight becomes apparent, when it is too late to check its ravages. The potatoes are generally well fertilized, 400 pounds to 1,000 pounds of a high-grade mixture, rich in potash, being used. Greater diligence in tilling and careful spraying will serve to increase the returns materially.

Tobacco is a very important crop on the Hagerstown and Conestoga soils in Lancaster and York Counties, and is grown to some extent in Chester, Lebanon, Berks, and Dauphin Counties. There were 41,742 acres of tobacco reported by the Thirteenth Census as grown in the State in 1909, and of this 32,783 acres were grown in Lancaster County and 6,134 acres in York County. This shows the relative importance of Lancaster County in the production of tobacco in Pennsylvania. Most of the tobacco grown is of the broad-leaf filler type, and yields from 1,000 to 1,600 pounds per acre. The crop needs very careful handling in order to produce a leaf of fine quality, and usually only from 4 to 5 acres are grown on a farm. Fields of over 10 acres of tobacco are rarely seen. The crop not only needs special care in its production, but it also must be very carefully

handled in harvesting and in the curing processes through which it passes after cutting. The tobacco farms have expensive curing barns of special construction to provide for the control of ventilation during the curing processes. In the larger towns and in Lancaster are large warehouses where the tobacco undergoes further curing and bulk fermentation before it is ready for manufacture. All of this calls for aptitude on the part of the grower, special facilities, and marketing conditions that tend to cause a localization of the tobacco-growing industry. Large quantities would have to be grown in other regions before it would pay to erect the warehouses and develop the local facilities for handling.

The tobacco crop receives very heavy fertilization. Barnyard manure is used freely and large quantities of high-grade fertilizer are also applied. Sometimes the tobacco field receives a disproportionately large part of the manure and fertilizers used on the farm.

The grass crop occupies by far the greatest acreage of any of the crops grown in the area, 888,086 acres being reported as in grass by the Thirteenth Census. Grass is usually seeded with the winter grain in all of the northern counties, the timothy sowed in the fall and clover in the spring. Sometimes the grass is seeded with oats or buckwheat as a nurse crop, but this practice is rare in the area surveyed. In many of the southern counties the grass is not sown with a nurse crop at all, but the wheat or rye stubble is disked or plowed shallow, and the grass sown alone on this land in August or early in September. Excellent results are obtained by this practice. Clover and timothy are the most common hay crops. The land is usually left in grass for two or more years. The first season's crop is largely clover, with some timothy, while the second season it is nearly all timothy. If left for more than two years the yields decrease materially and the quality becomes poorer, the clover and timothy being displaced by redtop and other native grasses and the fields becoming weedy. In some sections the lands are mowed for from two to five years, then pastured for one or more seasons. Such practices deplete the soil fertility and are not profitable, as the returns per acre are very low. If the meadows are to be mowed for more than two seasons they should receive applications of manure or fertilizers to keep up the yields. Excellent results have been obtained by this method at the State experiment station on wornout Hagerstown soils.¹

Alfalfa is grown to some extent in every county, but the acreage in this crop is nowhere very extensive. On the well-drained soils the crop is quite successfully grown. Two or three cuttings are obtained, giving a total annual yield of from 3 to 5 tons per acre.

¹Bul. No. 101, Penn. Agr. Expt. Sta.

Nearly every farm in the whole area has a small orchard, with several varieties of apples, some peaches, pears, plums, etc., but these supply only the home needs or the demands of the local markets. There are few commercial orchards within this area, though some of the soils, as shown by the results in these orchards, are well adapted to both apples and peaches. Some large orchards are being set out, the greatest activities being on the Chester, Penn, Upshur, and Volusia soils. There seems to be no reason why the area should not some day become a great fruit-producing region, the quality and quantity of apples and peaches grown being equal to those produced in the best of the present orchard regions. A comprehensive report on the Pennsylvania fruit soils,¹ by H. J. Wilder, of this bureau, has shown the character of soil on which the different varieties do best and the varieties adapted to the soils of the State.

Market gardening and truck farming is carried on near all the large cities and near the mining towns in the mountain region. In the vicinity of Philadelphia market gardening is a highly specialized industry. There are excellent opportunities for extending the gardens in this region, and even better opportunities near the smaller towns. The river bottom and terrace soils along the Susquehanna and Delaware Rivers are very well adapted to trucking and gardening, and with excellent local markets there is every incentive for extending the industry.

The products of the dairies form a very large part of the cash sales made from the farms in all parts of the area surveyed. Philadelphia's milk supply comes very largely from the near-by regions in this area, the milk coming in the morning and evening in milk cars or on special milk trains. Reading, Allentown, Easton, Lancaster, Wilkes-Barre, and the other important towns demand large quantities of milk daily, besides the butter and cream (as cream or as ice cream) consumed. The dairies supplying milk to the larger cities are generally very good, with high-grade cattle and clean stables and surroundings.

The Guernsey and Holstein breeds are most common on the dairy farms. Many excellent herds of thoroughbred Guernseys, Holsteins, Jerseys, and Ayrshires are to be found in the region. The dairymen are handling their herds in an up-to-date manner. The smaller herds, and especially the average farm dairy, is not well cared for. The cattle vary greatly, with scrubs in the majority. Most of the milk produced is sold whole or as cream, for consumption as such. There are few creameries and almost no cheese factories in the area. One large milk-chocolate factory uses the output of many herds in its vicinity.

¹ An. Rept. Pa. Agr. Expt. Sta., 1911, pp. 512-567.

Manure is in general use over the area, being usually applied to the corn land in the spring and to the wheat land in the late summer or fall. On the Hagerstown and Conestoga soils of Lancaster and York Counties most of the manure is applied to the tobacco land. Considerable loss is suffered through leaching and washing away of the more soluble fertilizing materials. On most farms the manure is stored in open yards, exposed to leaching by water from snow and rains. The loss of fertility occasioned in this way has been shown to be very large, and covered manure sheds would soon effect enough saving to pay their cost and maintenance. Manure spreaders are used on nearly all farms, and through the even distribution make it possible to cover more of the farm with the available supply of manure. Tests at the experiment station¹ have shown that 8 or 10 tons per acre is the most profitable application, where the general farm crops are grown.

Fertilizers are used on nearly all farms. On the tobacco and potato fields from 1,000 to 2,000 pounds per acre is often applied, but on wheat the usual application is 200 to 250 pounds per acre. The special fertilizers are usually "high-grade" mixtures, prepared for the needs of the crop to which applied. Many growers or communities have their own preferred formulas and there are many small fertilizer mills where special brands are mixed to order. The farmers who are growing the standard crops of corn, oats, wheat, and grass apply smaller quantities of fertilizers and do not pay much attention to the formula, purchasing largely by brand name and price.

In some sections the soils are badly in need of lime. The Penn and Lansdale soils of the Piedmont region, the Upshur soils of the Appalachian region, and the Volusia soils in the glaciated region are generally much improved by applications of from 1 to 2 tons of lime per acre. Local areas of the other soils are benefited by applications of lime, but on these soils it has been in more constant use and they are not so uniformly deficient in this constituent. There are unlimited supplies of limestone in the great valleys, and lime can be gotten at low cost in all parts of the area. The lime content of the soil must be maintained if clover and alfalfa are to be grown successfully.

Deeper plowing and more thorough harrowing and cultivating would make for increased crops. Most of the soils lie on slopes, and, as has just been said, are deficient in humus. With deeper plowing, making loose and porous a deeper layer of the surface soil, more of the rain water would be absorbed and the run-off lessened. The tables of annual rainfall show considerable rain during the growing seasons, but there are many short droughts that occasion decided decreases in the crop yields. Better harrowing and more thorough and longer

continued cultivation would serve to reduce the loss of moisture by evaporation and tide the crops over these periods of drought. The common practice of "laying by" the corn and potatoes early in June leaves them subject to the July droughts. Cultivation should be continued as long as the horse and tillage implement can pass between the rows without injury to the plants, thus maintaining the mulches as late as possible in the summer.

In the southern counties the farm buildings are uniformly large and substantial, often of stone or brick and always very well built. Fences and outbuildings are generally excellent. In the northern counties the same conditions prevail in the best agricultural districts, while in the more remote sections the buildings are poor, the fence rows weedy, and the fences in a poor state of repair. In many cases, over the whole area, the buildings are larger and more extensive than the size of farms warrants, farms often selling for less than the buildings are actually worth.

Farm machinery is generally up to date and plentiful. In parts of Bucks and Northampton Counties nearly every farm is supplied with a grain thrasher and separator. These are in use for only a few days each year. Undoubtedly cheaper service could be gotten by hiring itinerant thrashers of larger capacity instead of investing the capital in the small thrashers and engines. Another serious fault is neglect of machines. Mowers or reapers may be left in the fields, without shelter, for months at a time. The machinery should be more generally housed and cared for when not in use. The farms of the region are generally very well supplied with the necessary farm implements and machinery.

One of the most serious problems for the farmers to solve is the supply of satisfactory labor. Over most of the area labor is scarce and of inferior quality. The better men are attracted to the mines and mills by the higher wages and shorter hours of labor. The best solution of the problem seems to be in so arranging rotations that a stated number of men can be profitably employed throughout the year, and in trying, by means of good wages and surroundings, to keep good men on the farms the year round.

Most of the farms in the region surveyed are operated by the owners. Very often a farmer, owning a small farm, will rent additional acres, thus appearing as owner and also as tenant. About 70 per cent of the farms are operated by the owners, the remainder being about evenly divided between share and cash rent tenants.

The following table shows the average size of farms, the proportion of improved and unimproved land, and the proportion of farms operated by the owners and by tenants, by counties, according to the Thirteenth Census:

Number and size of farms, proportion of improved and unimproved land in farms, value per acre, and tenure of farms, by counties.

County.	All farms.	Approximate land area.	Land in farms.	Improved farm land.	Average size.	Average area improved.	Average value per acre.	Farms operated by owner.	Farms operated by tenant.
	Number. 219,295	Acres. 28,692,480	P. ct. 64.8	P. ct. 68.2	Acres. 84.8	Acres. 57.8	Dollars. 33.92	Per cent. 74.9	Per cent. 23.3
Berks.....	6,953	553,600	82.8	83.2	65.9	54.9	31.17	63.4	34.5
Bucks.....	6,020	389,120	90.7	84.5	58.6	49.5	34.63	74.8	22.8
Carbon.....	936	259,840	37.1	41.6	102.9	42.8	13.99	89.1	7.7
Chester.....	5,666	497,280	85.2	82.9	74.8	62.0	42.06	69.2	27.7
Columbia.....	2,777	306,560	74.4	71.9	82.1	59.0	19.71	75.6	22.8
Dauphin.....	2,684	333,440	64.3	79.5	79.9	63.5	33.75	61.8	34.9
Delaware.....	1,429	118,400	69.7	81.8	57.8	47.3	160.85	57.9	35.5
Lancaster.....	10,835	602,240	91.4	85.9	50.8	43.6	69.90	61.1	37.3
Lebanon.....	2,525	230,400	75.3	85.7	68.7	58.9	46.17	61.4	35.6
Lehigh.....	3,295	220,160	87.1	86.4	58.2	50.3	51.14	66.5	30.3
Luzerne.....	3,216	570,880	47.2	51.1	83.8	42.8	28.64	79.4	18.4
Monroe.....	2,097	398,720	51.2	47.7	97.3	46.4	12.59	87.3	11.6
Montgomery.....	5,166	309,760	81.3	88.4	48.7	43.1	109.74	71.1	23.5
Montour.....	849	83,200	89.6	80.7	87.8	70.9	20.90	64.7	34.4
Northampton.....	3,565	238,080	80.9	86.0	54.0	46.5	36.29	68.1	30.3
Northumberland...	2,534	290,560	72.8	77.7	83.5	64.9	25.49	70.2	28.1
Philadelphia.....	824	85,120	35.8	85.3	37.0	31.6	795.33	37.1	56.8
Schuylkill.....	3,002	497,280	43.5	65.8	72.1	47.4	25.03	84.0	14.5
York.....	8,460	577,920	92.1	81.5	62.9	51.2	30.01	70.0	28.5

It will be seen that the size of farms varies from 37 acres in Philadelphia County and 50.8 acres in Lancaster County to 102.9 acres in Carbon County. The area of improved land does not vary so widely, with 31.6 acres in Philadelphia, 43.6 in Lancaster, and 42.8 acres in Carbon County. Montgomery County has the largest percentage improved, 88.4 of the total area in farms being classed as improved land. The average values, as shown by the Thirteenth Census, are low. Philadelphia County, lying wholly within the city limits, is not strictly farming land, and Montgomery and Delaware, with values at over \$100 an acre, are affected by the urban and suburban land values. Outside these counties, Chester (\$42.06) and Lancaster (\$69.90) show the highest values per acre, while Monroe (\$12.59) and Carbon (\$13.99) are lowest.

The region of southeastern Pennsylvania offers some of the finest opportunities for agricultural development to be found in the country. The land is cheap, considering the productiveness of the soils, the proximity to markets, and the desirability of the section as a place of residence. Many farms, within two hours ride of Philadelphia, with good soils, good buildings, excellent water, and healthful climatic conditions can be purchased at \$40 to \$100 an acre. The

soils are adapted to general farming, or to potatoes, apples, and other special crops, and need only intelligent handling to make farming very profitable.

SOILS.

Thirty-three series of soils, excluding Meadow, Muck, and Rough stony land, were mapped in this area. All of these series of soils are distinct in character and, with the exception of the glaciated soils and the bottom soils, are closely related to the underlying geological formations.

The area surveyed embraces practically every geological formation found in the State. In the southeastern counties, in a belt from 2 to 6 miles in width along the Delaware River south from Trenton to the State line, lie the comparatively recent unconsolidated formations of Coastal Plain deposits. Small fragments of the Lafayette formation are found, but most of the soil material is derived from the Pensauken and Cape May formations of Pleistocene age. These materials give rise to the soils of the Sassafras series.

Underlying these deposits and extending westward across Chester, Lancaster, and York Counties are the igneous and metamorphic rocks which where exposed give rise to the soils of the Piedmont Plateau. The extensive mica gneisses, mica schists, and the gabbros and other granitic rocks, when weathered, give the Chester soils, while the hydromica schists and schistose gneisses give the very micaceous Manor soils. Both these series occupy rolling to hilly topography and on the steeper slopes often are badly eroded. Throughout the area occupied by these formations occur some areas of intruded serpentine and associated rocks. These weather slowly into a poor soil, giving the Conowingo series. The soils which are unproductive are of small extent. In a few scattered areas the Cecil soils are found, formed by the weathering of syenites, gabbros, diorites, and other trap rocks, while in southern Lancaster and York Counties the Cardiff soils, derived from beds of hard, dark-colored slates, occur.

Deposits of Triassic material, red to gray sandstones and shales, lie in a broad band north of the area just described, occupying a large part of Bucks, northern Montgomery, southern Berks, and northern Lancaster and York Counties. Two series of soils are derived from these rocks, the Penn from the red rocks and the Lansdale from the drab, yellow, and gray rocks. These soils occupy a less broken topography, gently rolling to somewhat hilly, and in some areas are rather poorly drained. Some small areas of Lickdale (colluvial) soils are found in these sections.

The ranges of rocky, wooded hills or mountains, known, in different sections, as the Reading Hills, South Mountains, and Welsh Mountains, made up of masses of igneous rocks with some sedimentary rocks, are occupied largely by Chester, Penn, and Lansdale, with

some Montalto, Dekalb, and Athol soils. Most of these ridges and mountains are forested, but some sections are suitable for use in growing orchard or general farm crops.

The Great Valley, lying just north of the ridges just described, between them and the Blue (or Kittatinny or North) Mountain, and the broad Lancaster Valley are derived from outcrops of the massive Silurian limestones, grouped as the Trenton limestones. These rocks, where massive and relatively pure, give rise to the Hagerstown soils, and when of schistose character, as on the south side of the Lancaster Valley, to the Conestoga soils. These two series are the most productive in the area and occupy country of gently rolling topography. The narrow, zigzag outcrops of the Lower Helderberg limestone, on weathering, give Hagerstown soils, generally the clay loam, clay, or stony clay types. The largest and most important area of soils from this formation lies in western Montour County, where they form a body of very productive lands. In one small area in southern Northumberland County the Frankstown soils are found. These are derived from the Lower Helderberg limestones and the Onondaga waterlimes.

In Berks County, a series derived from small areas of Potomac marble—a limestone conglomerate—and other formations, largely lime bearing, is found. This has been given the name Athol. On the north side of the Great Valley (locally known in different sections as the Kittatinny Valley, Lebanon Valley, and Cumberland Valley) and on the north side of the Lancaster Valley occur extensive outcrops of the Utica and Hudson River slates and shales, which weather to form the hilly areas of Berks soils. North of these soils, along the north boundary of Northampton, Lehigh, Berks, and Lebanon Counties, the Blue Mountain forms a dividing line between the rolling lands of the southern counties and the hilly and mountainous northern regions. Blue Mountain is made up of the Medina and Oneida sandstones, has steep, rocky slopes, and has a crest of remarkably uniform elevation—about 1,500 feet above sea level. North of this mountain occur a series of more or less parallel ridges made up of hard sandstones—the Medina-Oneida or the Pottsville and Pocono—with intervening lowlands in which the soils are derived largely from shales—the Mauch Chunk and Catskill giving the Upshur, while the Chemung, Portage, Genesee, Marcellus, etc., give rise to the Dekalb soils. The sandstones also give the Dekalb soils, usually the stonier and less productive types.

The northern and northeastern parts of the area have been glaciated. The ice sheet, moving south over the country, ground up and transported quantities of rock material, which, as the ice melted, were dropped as a layer of till, or in heavier deposits, as moraines. The ice-laid deposits are nowhere deep, and in general are made up of

material of local derivation. Over most of the glaciated area the soils are grayish colored and consist of shale material mixed with glacial till. These soils have been mapped as the Volusia series.

In a few areas the red glaciated soils—the Lackawanna series—are found. In its southward movement the ice overrode Kittatinny (or Blue) Mountain and deposited a thin coating of material over the shales lying to the south. These soils (in origin glaciated Berks) are classified as the Dutchess series, and in this survey are found only in Northampton County. They are extensively developed east of the State in New Jersey and New York.

Along the streams a number of distinct bottom land and terrace soils are found. In the glaciated region, where the alluvial deposits are largely from reworked ice-laid material, the terrace soils are correlated with the Chenango series, while the light-colored bottom-land soils are placed in the Genesee series and the red bottom-land soils in the Barbour series. The latter are not extensive, being found only in Columbia County. Where the terraces are made up partly of transported glacial material and partly of material from the residual uplands, the soils are placed in the Wheeling series. These are extensively developed along the Susquehanna and Delaware Rivers. In a few areas, terraces made up wholly or largely of local material from the residual uplands, chiefly sandstone and shale soils, give rise to the Holston soils. These are not extensively developed. The Birdsboro is another terrace soil, found along the Schuylkill River, derived principally from Appalachian, Limestone, and Piedmont material. In the stream bottoms in the residual regions the Huntington soils are generally found, with some Schuylkill soils where the wash from the culm banks has mixed in large quantities of coal dirt and given a black color. Many of the stream bottoms are very narrow and are subject to overflow at times of heavy rains. These soils are largely too wet for cultivated crops, and are classed as Meadow. They are of little value in their present condition, except for pasture. A few areas of Muck are mapped in the glaciated region in Luzerne, Carbon, and Monroe Counties. Some of these, if drained, would prove well adapted to onions, celery, cabbage, and similar crops. In their natural state they support a growth of cattails, rushes, and other water-loving plants. Rough stony land areas have been indicated on the map by suitable symbols on the prevailing series color.

The various soil groups discussed in this report are shown on the accompanying map by means of colors, and the interested reader is referred to this map for information concerning the occurrence and distribution of the soils. To enable a better understanding of the existing conditions as regards the suitability of the various areas

for farming, so far as surface features are concerned, the rougher parts of the county have been indicated on the map by means of hatching. Such differentiation must, of course, be rather general in character, but in the absence of a more exact topographic map should prove of value. Areas shown by the hatching are not adapted to agriculture.

The following table gives the name and extent of each of the soil series mapped in the survey:

Areas of different soils.

Soil.	Acres.	Per cent.	Soil.	Acres.	Per cent.
Dekalb soils.....	1,586,176	24.2	Herndon soils.....	13,376	.2
Chester soils.....	867,466	13.2	Schuylkill soils.....	12,608	.2
Volusia soils.....	807,808	12.3	Lackawanna soils.....	12,288	.2
Berks soils.....	611,136	9.3	Rough stony land.....	11,200	.1
Hagerstown soils.....	543,808	8.3	Genesee soils.....	9,920	.1
Penn soils.....	519,680	7.9	Conowingo soils.....	9,728	.1
Upshur soils.....	389,152	5.6	Lickdale soils.....	7,104	.1
Manor soils.....	320,384	4.9	Barbour soils.....	5,760	.1
Lansdale soils.....	292,032	4.4	Birdsboro soils.....	5,440	.1
Sassafras soils.....	127,424	1.9	Frankstown soils.....	4,992	.1
Conestoga soils.....	76,864	1.2	Holston soils.....	4,544	.1
Wheeling soils.....	71,616	1.1	Muck.....	4,224	.1
Chenango soils.....	57,024	.8	Athol soils.....	3,904	.1
Montalto soils.....	42,496	.6	Decatur soils.....	2,624	.1
Cecil soils.....	39,808	.6	Cardiff soils.....	1,856	.1
Dutchess soils.....	37,312	.5	Ashe soils.....	1,088	.1
Huntington soils.....	34,368	.5	Hanceville soils.....	448	.1
Edgement soils.....	27,328	.4	Total.....	6,562,560	.....
Meadow.....	19,584	.3			

UPLAND RESIDUAL SOILS.

DEKALB SOILS.

The Dekalb series includes residual soils derived from the weathering of sandstones and shales. The surface soils are generally gray to grayish brown in color, depending largely on the amount of organic matter present. The subsoils are light yellow to yellowish brown. Some included areas are poorly drained, and here the subsoil has a mottled gray, yellow, and drab color. The subsoil usually grades into broken rock and into bedrock at 2 to 5 feet below the surface.

The Dekalb series is the most extensive series in the area mapped, occurring in every county in the survey except Philadelphia and Delaware Counties. The Dekalb soils cover over two-thirds of the whole area of Schuylkill, Northumberland, Montour, Columbia, and Carbon Counties, and there are large areas in Monroe, Dauphin, and the other counties in the survey.

These soils occur in three characteristic topographic positions, on the tops and flanks of the mountain ranges, on the hilly foot slopes and in hilly lowland belts. The soils on the mountains in Schuylkill County, in eastern Northumberland, southern Luzerne, and northern Carbon and Monroe Counties, are derived from the Pottsville conglomerate, Pocono sandstone, and from the sandstones and shales of the Coal Measures. Practically all the other mountain regions, nearly all of which are mapped as Dekalb, are composed of rocks of Medina-Oneida formation or Pocono sandstone. All these latter mountain regions occur as narrow mountain ranges, with steep, stony, wooded slopes.

Where the soils are derived from the Chemung, Portage, Genesee, Marcellus, or Hamilton formations (No. VIII of Second Pennsylvania Geological Survey), or from the light-colored Catskill rocks, the topography is that of a hilly lowland, with a series of steep-sided, round-topped ridges that have been cut into a succession of rounded hills and hog-backed ridges. In these regions the soils are largely in farms, and in some of the valleys, where the topography is rolling rather than hilly, excellent farming lands are found. Some of these lowland belts are, from a local viewpoint, hilly or ridgy uplands.

As a rule, the Dekalb soils are naturally well-drained, though wet areas are encountered near the headwaters of streams and along seepage lines on the hill slopes.

Six types of the series, including the Rough stony land, are found within the present survey.

The Rough stony land consists of those areas which, because of the large amount of stone and rock fragments present and because of the steeply sloping surface, are not suitable for cultivation, though adapted to some extent for use as pasture.

The Dekalb stony loam consists of 6 to 8 inches of gray or grayish-brown loam or heavy sandy loam, grading into a yellowish or mottled compact clay loam subsoil, occasionally somewhat sandy. Both soil and subsoil contain large quantities of angular sandstone and shale fragments.

The surface soil of the Dekalb gravelly loam consists of 4 to 6 inches of gray or yellowish-gray rather gritty loam or sandy loam, containing 40 to 60 per cent of rounded quartz and sandstone pebbles of small size. The subsoil is a yellowish sandy, gravelly, heavy loam, containing numerous stone fragments. The soil is derived from the well-weathered Pottsville conglomerate and is usually of little agricultural value, practically no farms being located on it.

The surface soil of the Dekalb shale loam consists of 6 to 8 inches of yellowish or grayish-brown silty loam, containing 20 to 60 per cent of small flat shale fragments, underlain by yellow or grayish-

yellow silty clay, carrying much more shale and grading into broken rock at 18 to 20 inches.

The Dekalb silt loam surface soil consists of 6 to 8 inches of gray to grayish-brown silt loam, resting on a yellow or mottled silty clay subsoil.

The surface soil of the Dekalb loam consists of 6 to 8 inches of brown or grayish-brown fine loam, resting on yellowish heavy loam grading into clay loam or clay.

Between one-half and two-thirds of the Dekalb area is unfit for agricultural use, lying on the mountain tops and sides. Part of this area is covered with a good second growth of timber. This is true of most of the narrow mountain ranges. On the broad plateaus the soils are covered with brush and scrub oaks. Here recurring forest fires have killed all the valuable young trees and the region is now in a desolate condition.

Where the Dekalb soils are farmed they are devoted to the general farm crops—corn, oats, wheat, rye, potatoes, buckwheat, and grasses.

Fruit growing is being developed on the Dekalb soils to a considerable extent and good results are obtained. Apples and peaches seem to do well, though there are few orchards of any size now in bearing. With care and fertilization selected areas of these soils should give good results with fruit.

Land values vary greatly over the Dekalb region. The stony, cut-over lands are held at less than \$10 an acre, except where the value is higher on account of the coal deposits beneath the surface. Agricultural land ranges from \$15 an acre to \$65 or \$75, depending on location, character, and condition of improvements. The average value of the areas suitable for farming is about \$35.

Northumberland County.—In Northumberland County the Dekalb soils cover about four-fifths of the total area, being interrupted only by the bands of Upshur soils and smaller bodies of the Hagerstown, river-terrace, and bottom-land soils. About one-fourth of the Dekalb area occupies the flanks and tops of Mahanoy, Line, Big, and Little Mountains, in the southern part of the county, and Montour Mountain north of Northumberland. On these mountains practically the only type of soil is Rough stony land, with some stony loam on the lower slopes. The remaining Dekalb area occupies the rolling to hilly lowland belts, derived largely from the Chemung, Portage, Hamilton, and Clinton formations. Some of this country is comparatively rough, consisting of a series of steep-sided narrow ridges, with little soil well suited for farming. Most of the lowland-belt areas, however, consist of moderately rolling to somewhat hilly country, with the larger part of the land in farms. The townships north of Montour Mountain have this

moderate relief and make up a highly developed agricultural section, with well-tilled farms, good fences and buildings and relatively large crop yields. Good farming sections are found also about Elysburg and Union Corner, in the southern part of the county, and in other valleys in that region.

The shale loam is the prevailing type in the farmed lands of the county, though there are large areas of the loam and the silt loam in the best sections. The stony loam occurs in large areas on the rougher hills and along the mountain slopes.

The soils, especially the shale loam, are subject to damage from erosion and care must be taken to prevent this. Contour farming and leaving strips of sod along the slopes are found materially to reduce this waste. Deeper plowing and the incorporation of organic matter in the soil materially increase the productiveness. The soils are greatly benefited by applications of lime.

The Dekalb soils in Northumberland County are devoted mainly to the general farm crops, with hay as one of the important products in the southern part of the county. Potatoes and wheat are the leading money crops in the northern townships. Dairying is an important farm industry over the whole county. Considerable interest is shown in fruit growing and many orchards are being put out, especially on the shale loam. Apples and peaches do quite well. Small fruits, berries, and strawberries also thrive, giving an excellent quality of fruit. Considerable trucking is done near the larger towns.

Land values vary greatly, in the rougher parts ranging from \$20 to \$40 an acre, while in the better farmed sections the land ranges from \$40 to \$60 an acre, with many farms valued at \$100 an acre.

Montour County.—In Montour County the Dekalb soils cover nearly the whole area. The soils occupy a rolling to moderately hilly topography, with Montour Mountain and some other rough mountainous regions in the southern part of the county. Agricultural conditions are practically the same as in northern Northumberland County.

Columbia County.—The Dekalb soils also cover the larger part of Columbia County, occupying practically all of the county lying west of Fishing Creek and the larger part of the county north of the Susquehanna River. In the southern townships the soils are derived from the Pocono and Pottsville formations and occupy country of rough, hilly to mountainous topography, with few really good farming sections. The best Dekalb areas in this region lie in Locust Township, and have rolling to rather hilly topography.

The northern section of Dekalb soils has a rolling to moderately hilly topography and is generally devoted to farming. In this region the loam, shale loam, and silt loam types are extensively developed, while in the southern part Rough stony land and the stony loam are the more extensive.

The general farm crops are grown, with good yields. Corn averages 40 to 50 bushels, oats 30 to 40 bushels, wheat 15 to 25 bushels, and hay 1 to $1\frac{1}{2}$ tons per acre. Potatoes yield 75 to 150 bushels per acre. Buckwheat does well.

Some fruit is grown on every farm. Apples give good results, and some commercial orchards are being set out. Peaches do fairly well.

Land values in the county vary considerably. In Greenwood Valley, the best area of Dekalb soils in the county, prices range from \$40 to \$60 an acre. In other regions the prices may go as low as \$20, with an average of about \$35 an acre.

The soils are quite subject to erosion, and are low in organic-matter content. Lime is beneficial and is in quite general use in the better farming sections. Fertilizers are generally used.

Schuylkill County.—In Schuylkill County the Dekalb soils cover over four-fifths of the total area, and more than two-thirds of this area is derived from the Pocono, Pottsville, and Coal Measure formations and occupies rough eroded plateaus and steep mountain slopes; with little or no land suited to agricultural use. Most of this rough region is covered with brush and scrub oaks, though there are some good forested areas and a few sections in the Coal Measures where some farming is being carried on. The Rough stony land and the stony loam are the most extensive types, with some large areas of the gravelly loam, and small areas of silt loam and shale loam.

In the southern part of the county, south of Second Mountain, is an area of Dekalb, derived from the Chemung, Portage, Hamilton, and Catskill formations, which occupies a rolling to hilly ridged valley. This strip of Dekalb, which is cleared and in farms, has a width of 4 to 10 miles, and extends the full length of the county north of its southern boundary, crossing Pine Grove, Washington, Wayne, North and South Manheim, East and West Brunswick, and West Penn Townships.

The shale loam, silt loam, and loam have about the same extent in this region. There is some stony loam on the steeper slopes. The farms are devoted to the general crops, with good yields. Corn averages about 50 bushels, oats 40 bushels, wheat 20 bushels, potatoes 100 bushels, and hay $1\frac{1}{2}$ tons per acre. In the better sections the yields are considerably higher than the figures given.

The soils generally are deficient in lime, and over most of the region lime is being used. The soils respond to applications of manure or to plowing under of green crops, as they are usually deficient in organic matter. Normally, they are well drained; in fact, most of them are inclined to be droughty. Erosion is severe where it is not guarded against. It is particularly active on the shale loam and loam in West Penn Township and on the steeper slopes above the creeks in the whole region.

Land values range from \$20 to \$70 an acre, depending on location and condition. A fair average value is about \$40 an acre for a farm with good buildings, fences, and other improvements.

Luzerne County.—The Dekalb soils occupy an area in the southwest part of Luzerne County, where they are derived largely from the Pottsville conglomerate and the Coal Measures. The soils occur on an eroded plateau and are mostly classed as the Rough stony land and the loam types. Some silt loam and gravelly loam areas are found. The soils are not well suited to agriculture, and there are few areas devoted to farming. Near some of the larger towns small farms and gardens exist, but the yields are low and crop failures common. The soils are loose and open and crops suffer severely during dry seasons. The mountainous areas are covered with brush and scrub oak, and a few with better forests. Most of the land is owned by coal operators.

Carbon County.—All of the Dekalb soils in Carbon County, except those in East Penn, Mahoning, Franklin, and Upper and Lower Towamensing Townships, occupy mountainous and plateau country, covered with brush and scrub oak, and are of no value for farming.

In the townships named the topography is steeply rolling to hilly or broken. Here the silt loam type is most extensively developed, though the shale loam and loam also occur in large areas. The loam is the most productive of these soils. On account of the steep topography, the areas are subject to damage by erosion; deep gullies quickly form in a field if not protected. The soils are droughty and crops suffer severely during dry seasons. They are benefited by applications of lime and of organic matter.

The general farm crops are grown, corn yielding 40 to 60 bushels, oats about 35 bushels, rye 18 bushels, potatoes 100 bushels, and hay 1½ tons per acre. Wheat is not grown to any extent, rye taking its place as the winter grain.

Land values range from \$40 to \$60 an acre, depending on location and the character of improvements.

Monroe County.—The Dekalb soils extend east into Monroe County, those adapted to farming occupying parts of Polk, Eldred, Chestnut Hill, and Ross Townships. Soil conditions are essentially the same as in Carbon County, and crop yields, land values, and farm practices are similar. The Dekalb soils in Tunkhannock Township and on Blue Mountain are practically all Rough stony land of no agricultural value.

Dauphin and Lebanon Counties.—In Dauphin and Lebanon Counties the Dekalb soils occur only on the rocky tops and sides of the narrow mountain ranges that cross these counties. There are six of these ranges—Blue, Second, Third, Peters, Berry, and Mahantango Mountains—and the broad, rough end of Broad Mountain which

enters the northeastern end of Dauphin County. There is one small area of rolling Dekalb soils north of Halifax made up mostly of shale loam and loam. On the mountains Rough stony land covers most of the area, with stony loam and some loam and clay loam on the lower slopes. These lower slopes are cleared and used for the production of the general farm crops. Some fruit is grown on the loam and stony loam. Most of the stony loam and some of the rough stony land is used for pasturage.

The mountains are forested, and there are some areas of valuable timber. They are adapted only to forestry.

Berks County.—In Berks County the Dekalb soils occur on Blue Mountain and along the slopes of South Mountain. Scattered areas were also mapped on the top of South Mountain and on the slopes around Oley Valley. Blue Mountain is mostly Rough stony land, and on South Mountain there are many areas falling in the same category.

On the lower slopes of Blue Mountain there are many areas of stony loam, and this type makes up the larger part of the Dekalb soils on South Mountain. Some small areas of Dekalb loam were found. The arable portions of these soils occupy steep slopes and generally have hilly topography and are relatively low in agricultural value. The soils are very stony and with the rapid surface drainage are subject to severe erosion. The soils do not hold moisture well, and crops suffer from drought during dry seasons. Crop yields are low, corn yielding 12 to 35 bushels, oats 20 to 25, wheat 12 to 16, and hay one-half to three-fourths ton per acre. The yields obtained on the loam are somewhat higher than those given for the soils as a whole. Most of the area is better suited to forestry than to agriculture. Farm land ranges in value from \$15 to \$45 an acre.

Lehigh County.—In Lehigh County the Dekalb soils occupy positions similar to those in Berks County. Scattered areas are found on South Mountain and on some of the ridges lying in areas of the Berks soils. Most of the Dekalb here is stony loam, though some loam areas occur. Blue Mountain is generally Rough stony land, with some areas of stony loam and loam on the lower slopes.

The soils are better adapted to forestry than to agriculture. The stony loam is extensively pastured. Crop yields are low, the general farm crops of the region being grown.

Northampton County.—The areas of Dekalb soils in Northampton County are essentially the same as those in Berks and Lehigh Counties. The largest area, composed almost wholly of Rough stony land, lies on Blue Mountain. Small areas of stony loam and loam occur on the lower slopes, between the rough land and the Berks soils. On South Mountain, south of the Lehigh River, some areas of Dekalb soils also occur. These are partly Rough stony land and partly stony loam. A few areas of loam and silt loam occur here.

Only a small part of these soils is farmed. Considerable areas are in pasture, but by far the greater part of their area is in forest. Rather low yields of the general farm crops are obtained where the soils are farmed.

Bucks County.—In Bucks County the Dekalb soils are found on the south flanks of South Mountain and on a few stony ridges in the northern part of the county. A few rolling areas exist, though the topography is in general steep and broken. Rough stony land and stony loam are the prevailing types, with loam and silt loam as the types that are farmed. On the last two types drainage is rather poor. General farm crops are grown, corn yielding 40 bushels, oats 30, wheat 15, rye 15, and hay about 1 ton per acre. Land values vary greatly, but will average about \$35 for the farmed soils.

Montgomery County.—The Dekalb soils, as mapped in the detailed survey of Montgomery County in 1905, cover about 23.7 per cent of the area of the county. Of this the shale loam formed 21.7 per cent, leaving 2 per cent covered by the gravelly loam and stony loam. The Dekalb soils occur in the northern half of the county, and are closely associated with the Lansdale soils. The stony loam occupies steep, sharp ridges, but the other types occupy nearly level to moderately rolling or hilly topography. Drainage conditions are generally good, though there are some poorly drained areas, the latter occurring where the bedrock lies in a nearly horizontal position. On the whole the soils have a rather low water-holding capacity, and crops suffer considerably from drought during dry seasons.

The soils are devoted to the general farm crops. Reported yields on the shale loam are corn 40 bushels, oats 25 bushels, wheat 15 bushels, potatoes 100 bushels, and hay 1 ton per acre.

Chester County.—In Chester County the Dekalb soils occur as a narrow irregular band occupying the hills just north of the Hagerstown soils in Chester Valley and a large irregular area in West Caln and Wallace Townships. Smaller areas lie along the northwest boundary. Four types were found, the stony loam, loam, fine sandy loam, and shale loam. The last two are of small extent.

The soils have hilly, broken topography, in some areas, especially along the west and northwest boundaries, approaching mountainous. A large part of the Dekalb area is in forest or pasture. Where farmed, general farm crops are grown. Corn yields about 40 bushels, oats 35, wheat 15 to 20, rye 18, potatoes 100 bushels, and hay 1 to 1½ tons per acre. The shale loam type in its most productive area yields better than the loam. The sandy loam is used to some extent for market gardening.

Lancaster County.—Soils of the Dekalb series occur in several areas in Lancaster County, always on the ridges or mountains. A long strip of rough land extends from Gap west along the north flank of Mine

Ridge and along the south flank from near Quarryville to Christiana. The south flank is mostly stony loam, with some areas of loam. Another area occurs along the Chester County line on Welsh Mountain, near Mast, with another, mostly Rough stony land, on the north ridge of Welsh Mountain, south of Churchtown. A large part of the Dekalb areas are in forest. Where farmed, general crops are chiefly grown, with some tobacco and fruit. The soils seem well adapted to fruit, not only to apples and peaches, but also to cherries and plums and small fruits. They are well adapted to potatoes and the earlier truck crops.

The soils are inclined to be droughty, crops suffering severely in dry seasons. They are well drained as a rule, and on the slopes often wash badly.

York County.—In York County the Dekalb soils occupy a rather small area of mountain-slope country along the western edge of the county. The series is represented by a single type, the stony loam. By clearing off the stones some of the less sloping areas can be and to some extent are used for the general farm crops with fair success.

HERNDON SOILS.

The Herndon soils are derived chiefly from quartzite and quartzite conglomerate. This series is represented in this survey by a single member, the stony loam. The type consists of a yellowish gritty loam, underlain at about 12 inches by reddish-yellow gritty clay loam, which grades below into red friable gritty clay. Fragments of quartzite comglomerate and light-colored sandstone are abundant on the surface and throughout the entire soil section. The topography is rough to hilly, and cultivation is difficult over much of this type on this account, as well as on account of the abundance of rock fragments.

Lancaster and York Counties.—Two small areas of this soil were mapped in York County and a large area near Columbia and small bodies near Neffsville and Leacock in Lancaster County.

The Herndon stony loam is best suited to apples, peaches, plums, brambleberries, and strawberries. Much of it is forested.

UPSHUR SOILS.

The Upshur soils are red soils, derived from the weathering of red sandstones and shales. The surface soils vary from a brown to a yellowish red, but are typically of an Indian-red color. The subsoils are usually a dark Indian red, and heavier in texture than the surface soils.

The soils are found in every county in this survey north of Blue Mountain, but are most extensively developed in Northumberland, Dauphin, Schuylkill, Columbia, and Luzerne Counties, with smaller

areas in Montour, Carbon, Monroe, and Lebanon Counties. The soils generally occur in long, narrow strips, but a few broad, irregular areas are found in inclosed basins.

The soils are for the most part derived from the Mauch Chunk red shale and the Catskill shales and sandstones. A few small areas in Northumberland and Montour Counties have their origin in the Bloomsburg red shale member of the Clinton formation.

The soils occupy a variety of topographic positions. The areas derived from the Catskill rocks may occur as hilly ridged lowlands, on low hills, and in long, narrow bands on the foot slopes and flanks of the mountain ranges. All these areas are usually quite broken, with many steep slopes. The areas derived from the Mauch Chunk formation occupy rolling to moderately hilly lowland and basin areas, with some bodies extending well up the slopes of the mountain ranges and outlying knobs. The soils from the Mauch Chunk formation are stronger and more productive than those from the Catskill rocks.

The Upshur soils are normally well drained, there being few areas that are damaged by seepage or by excess of ground water. Where the topography is steep they are easily washed, and severe losses are occasioned by sheet erosion and by the formation of gullies. The shale loam suffers severely, as it occupies steep rounded hills. The fine material is removed almost as rapidly as formed, and the soils kept shallow and full of broken rock.

Six types, exclusive of Rough stony land, were found, the stony loam, shale loam, loam, silt loam, fine sandy loam, and clay loam. Of these, the shale loam and loam are most extensive, the silt loam of moderate extent, and the stony loam, fine sandy loam, and clay loam of least areal importance.

The surface soil of the Upshur shale loam consists of 4 to 8 inches of a yellowish-red to a dark reddish brown fine silty loam resting on an Indian-red silty clay loam or silty clay subsoil. The soil contains from 30 to 60 per cent of red shale fragments, the percentage increasing with depth until broken rock is reached at from 12 to 30 inches.

The Upshur stony loam consists of 6 to 8 inches of dark Indian-red loam containing 40 to 70 per cent of flat, angular sandstone or shale fragments. The subsoil is a deep Indian-red silty clay or clay loam containing more stones.

The Upshur loam consists of 8 to 12 inches of a yellowish-red to deep-red mellow loam surface soil, resting on a silty clay loam or clay subsoil of a deep Indian-red color.

The surface soil of the Upshur silt loam consists of 8 to 10 inches of a soft brown and Indian-red mellow silt loam resting on an Indian-red silty clay loam grading into silty clay with depth.

The surface soil of the fine sandy loam consists of 6 to 12 inches of a brown or reddish-brown fine sandy loam, becoming heavier at 15 to 18 inches and grading into a dark Indian-red clay loam at 30 to 36 inches. In places considerable quantities of fine-grained shaly sandstone fragments are present.

The surface soil of the Upshur clay loam consists of 6 to 10 inches of a dark Indian-red or reddish-brown silty clay loam resting on a stiff tenacious somewhat mottled red clay subsoil.

The soils are adapted to the general farm crops, to potatoes, and to fruit and truck crops.

Northumberland County.—The Upshur soils occupy a large total area in southern Northumberland County, occurring in long narrow lowland belts. One strip lies along the southern boundary, just north of Mahantango Mountain, in a band from 1 to 3 miles wide. This area extends from the Susquehanna River eastward into Schuylkill County, swings back along the south side of Line Mountain, crosses the river into Snyder County, and swings back into Northumberland along the north side of Little Mountain, following it into Columbia County. A narrower strip lies inclosed between Line and Mahanoy Mountains, extending around and along the valley between Big and Little Mountains. These narrow strips occupy the lower slopes of the mountains and also the hilly ridges just beyond the foot of the mountains. The shale loam and loam are the most extensive types, with considerable stony loam. The soils are nearly all in farms and good crop yields are obtained. Corn, oats, wheat, hay, potatoes, and truck are grown. Considerable trucking is done near Shamokin. Land values vary from \$25 to \$50 an acre, depending largely on location.

In the northern part of the county are several areas of Upshur soils derived from the red Bloomsburg shale. Here the shale loam and loam are developed with some silt loam. The soils occupy low ridges and rounded hills and are well farmed. The general crops and potatoes are grown. Land values are high.

Montour County.—In Montour County the Upshur soils occur only in an area in Mayberry Township and in two narrow strips northeast of Danville. The latter occupy the lower slopes of Montour Mountain and the former includes a region of steeply sloping hills. Only part of the Upshur area is farmed, part being in forest. General farm crops are grown with fair yields.

Columbia County.—Extensive areas of the Upshur soils are found in Columbia County. One area occurs in the northern part, in Jackson Township, and another very productive area west of Orangeville. Other areas in the lowland belts in Beaver, Catawissa, Franklin, Roaring Creek, and Locust Townships are of considerable size and important from an agricultural standpoint. These soils all occupy rolling to hilly areas.

The larger part of the Upshur soils in this county is in farms, the areas constituting, with the exception of the river terraces, the most important farming sections in the county. General farm crops are the leading products, but the production of potatoes and truck crops is considerable and of fruit worthy of note. Crop yields are good. Corn yields 40 to 50 bushels, oats 30 to 40, wheat 18 to 25, potatoes 100 to 175 bushels, and hay 1 to $1\frac{1}{2}$ tons per acre. Land values range from \$35 to \$55, averaging about \$45 per acre.

The soils are generally in need of lime, which is in very general use. They are somewhat subject to erosion, but this is not severe, except in the steeper slopes. Plowing in manure or green crops materially improves the soil conditions and increases the yields.

Luzerne County.—The Upshur soils occur in one extensive area in the Conyngham Valley, in Luzerne County, with a smaller area in Nescopeck Township and two small areas east of Hazleton. The Nescopeck area is quite hilly, but the Conyngham Valley area occupies country of rolling to moderately hilly topography, with some steep slopes along the mountain sides and next the streams. This area is derived from the Mauch Chunk red shale, and the silt loam and loam are the prevailing types. Practically all of the land is in farms, most of which are in a very productive state. Drainage conditions are good, and erosion is not severe. Lime is in quite general use, giving good results. In many places the soils would be benefited by additions of organic matter.

General farm crops are grown, corn yielding 60 to 80 bushels, oats 30 to 45 bushels, wheat 20 to 30 bushels, and potatoes 100 to 200 bushels per acre. Considerable trucking is done in the Conyngham Valley, the produce being hauled to Hazleton, a good State road, leading over the mountains, giving easy access to this market. There is a market for more fruit and truck than is now grown.

Land values are comparatively high, ranging from \$65 to \$150 an acre.

Carbon County.—In Carbon County the Upshur soils are most extensively developed in the Weatherly Valley, with smaller areas in Mahoning, East Penn, Franklin, Towamensing, and Lower Towamensing Townships. The smaller areas have a hilly topography, with the shale loam and loam most extensively developed. Erosion is quite active. In the Weatherly Valley the soils occupy rolling country, with the loam and silt loam most extensive, and smaller areas of shale loam and clay loam. In this valley the greater part of the Upshur soils are in farms, while in the other areas considerable forested and pastured land is found.

The soils are farmed to the general crops, corn, oats, wheat, rye, hay, some potatoes, and buckwheat.

In the Weatherly Valley the yields are about the same as for the Conyngham Valley, in Luzerne County, with land values about the same. In the other valleys the crop yields are lower and the land values range from \$20 to \$75 an acre, depending on conditions and location.

Monroe County.—In Monroe County there are two important areas of Upshur soils. One occupies a broad valley in Polk and Chestnut Hill Townships, the other a hilly depression in Eldred Township. The soils for the most part occupy steep slopes, but there are some rolling areas. They are devoted to the general farm crops and, occurring in a region of rather poor Dekalb soils, form rather important agricultural sections.

Corn yields from 40 to 70 bushels, oats 25 to 45 bushels, wheat 15 to 25 bushels, rye 12 to 20 bushels, potatoes 75 to 150 bushels, and hay 1 to 1½ tons per acre. Land values range from \$30 to \$60 an acre, averaging about \$40 for farms in good condition.

The soils wash quite badly and are relatively low in organic matter. They are greatly benefited by the use of lime. Dairying is practiced to some extent, but could be greatly extended. Fruit does well on the soils, but there are few orchards of any size in the county.

Dauphin County.—There are two large areas of Upshur soils in Dauphin County, one in Lykens Valley and another in the broad depression lying between Berry and Peters Mountains. The soils in the former are derived from the Mauch Chunk formation, and in the latter from the Catskill rocks. The topography of the latter area is steeply rolling to hilly, with rounded hilltops and deep, narrow, V-shaped valleys. About three-fourths of the area is in farms, the general farm crops being grown. Shale loam and loam are the prevailing types, the soils being rather shallow and droughty. They are, however, fairly well adapted to fruit and to potato production, with proper methods of fertilization and tillage.

In the Lykens Valley, including the whole area between Mahantango and Berry Mountains, the soils have a moderately rolling to somewhat hilly topography. The loam is the most extensive type, with considerable areas of silt loam, shale loam, and small areas of fine sandy loam, stony loam, and clay loam. Practically all of the area is in farms, the general farm crops being grown. Corn yields from 70 to 100 bushels, oats 30 to 60 bushels, wheat 15 to 25 bushels, rye 15 to 25 bushels, potatoes 80 to 150 bushels, and hay 1 to 2 tons per acre. Rye is grown quite extensively by the tenant farmers, as under the usual agreements it may be fed on the farm and need not be divided and sold.

Apples and peaches seem well adapted to these soils, and where grown give good yields of a good quality of fruit. There are few well

cared for orchards, and no large orchards in bearing. Potatoes do well, and the acreage devoted to the crop could well be extended. Dairying is a common farm industry, the products being marketed in the coal mining towns to the east.

The soils are greatly benefited by applications of lime and much more of this material should be used. Increasing the depth of plowing, and turning under green crops also will greatly increase the productiveness of all the Upshur soils in the county.

Prices for land of the Upshur types in the Lykens Valley range from \$40 to \$100 an acre, with many farms held for more than the higher figure. In the valleys about Halifax prices are lower, ranging from \$30 to \$60. In general the yields are somewhat lower on the soils from the Catskill rocks than on those from the Mauch Chunk formation.

There are three narrow strips of Upshur soils lying between Blue and Second Mountains, Second and Third Mountains, and Third and Peters Mountains, occupying Fishing Creek, Stony Creek, and Clark Creek Valleys. These lie on the slopes and the small hills in the narrow valleys, and not over one-third of their area is farmed. There is no wagon road, only a trail, in Stony Creek Valley beyond Ellendale Forge. North of Dauphin, Stony Creek and Clark Creek Valleys unite to form a considerable area of rolling to hilly Upshur soils, with the loam and silt loam well developed. These soils are largely in farms, upon which the general farm crops and some fruit and truck are produced. The soils are productive and the farms in good condition. Corn yields compare well with those in the Lykens Valley.

Lebanon County.—Stony Creek Valley and the valley between Blue and Second Mountains extends across Lebanon County. The former is almost wholly in forest or cut-over land, and there are few farms. The latter is largely in farms. The topography is hilly, and the soils are subject to severe erosion. Shale loam and loam are the most extensive types. The soils are devoted to corn, oats, wheat, rye, and hay, with some potatoes and some fruit. Crop yields are fair.

Schuylkill County.—The Upshur soils form the most important agricultural sections in Schuylkill County and are quite extensively developed. The soils are derived from three formations, the most extensive and productive being the areas from the Mauch Chunk formation. The Catskill rocks give some extensive areas, and a long narrow strip along the southern boundary is derived from the Clinton formation.

In Upper Mahantango and Eldred Townships is a strip of Upshur about 2 miles wide, following the north and west flank of Mahantango and Line Mountains. This area is the eastern extension of the one in Northumberland County, and is cut off by the high mountains from the rest of Schuylkill County. The areas are steeply rolling to hilly. The land here is devoted to the production of general farm crops.

Between Mahantango Mountain and Broad Mountain, extending from the county line west of Sacramento northeast to beyond Fountain Springs, is the east end of Lykens Valley. The Upshur soils are here derived from the Mauch Chunk and have a rolling to hilly topography. They are quite productive and are devoted to the general farm crops almost exclusively.

In Union, North Union, and East Union Townships is a large irregular area of Upshur derived from the Mauch Chunk. The country is rolling to moderately hilly. The soils are quite productive, the loam and silt loam being most extensive, though there are large areas of the shale loam. A similar area occurs in Ryon and Rush Townships, north of Tamaqua. A smaller area derived from the Mauch Chunk lies in the Wiconisco Valley in Porter Township. All these areas are rated as productive farming regions. The soils are easily worked and give good yields of the general farm crops. Corn yields 50 to 90, wheat 15 to 25, oats 35 to 60, rye 15 to 25, potatoes 100 to 150 bushels, and hay 1 to $1\frac{1}{2}$ tons per acre. Some fruit is grown on each farm, and in the two larger areas in the north considerable trucking is done, the produce being sold in the near-by mining towns. The acreages devoted to truck, fruit, and potatoes could be very profitably extended. There is also an excellent market for dairy products.

In the southern part of the county there are several long strips of Upshur soils. Wide areas exist in East and West Brunswick and in West Penn Townships. These areas have a hilly topography in their wider parts, and occupy the lower slopes of the mountains and the valley floor in their narrower parts. The soils are not as extensively farmed as in the north, but are productive and give good yields of the general farm crops. Near Orwigsburg and near Pottsville some trucking is carried on. Some fruit is grown, but there are no large commercial orchards.

Land values range from \$15 to \$50 an acre. Good farming land is worth \$35 to \$50 an acre.

All of the Upshur soils of this county are benefited by the application of lime, and over a large part of the county it is being quite generally used. Deeper plowing and an increase of the organic matter in the soil also increase the crop yields. Fertilizers are in general use.

The Upshur soils are the best farming soils in the county, in the north being the only soils adapted to farming.

BERKS SOILS.

The Berks soils are derived from the weathering of thin-bedded shales and shaly sandstones. They have yellowish-brown to brown surface soils, with yellow or yellowish-brown subsoils of heavier texture. Both the soil and subsoil contain varying quantities of shale

fragments, and the subsoil usually grades into a mass of broken shale within the 3-foot section.

The soils occur in the Great Valley or Cumberland Valley, and extend in a belt from 8 to 16 miles wide across Dauphin, Lebanon, Berks, Lehigh, and Northampton Counties. They also occur in York and Lancaster Counties, south of the limestone valleys. The soils extend west and southwest beyond this area, through the Cumberland Valley. To the east, in Northampton County, the Berks area has been glaciated, giving rise to soils of the Dutchess series. In this broad belt the soils lie just east and south of the Blue Mountain.

The soils of the Berks series have a steeply rolling to hilly topography, composed of rounded hills and ridges and narrow V-shaped valleys. The areas usually lie from 100 to 300 feet above the limestone valleys that join them on the south, the descent to the valleys being abrupt. In places, where the Berks hills are of a uniform height, this "front" looks like the escarpment or edge of a plateau. There are considerable variations in elevation within the Berks areas, the hills rising from 500 or 600 feet above sea level to as much as 800 or 1,000 feet, with a few ridges even higher. The streams flowing across the Berks soils from the mountains on the north, with the streams that head in the Berks soils, have cut the surface into an intricate network of narrow V-shaped valleys.

Thin-bedded, fine-grained shales and shaly sandstones give rise to the soils of this series. These rocks vary in color from gray to brown, drab, yellow, olive, and red, though shales of gray and drab color make up by far the larger part of the rock mass. In places, usually on the higher elevations, layers of thin-bedded yellow or gray fine-grained sandstones are found. These latter give rise to the sandy loam and the stony loam types. Where the rock material is readily weathered and erosion is not too active to permit the accumulation of a considerable depth of material, the silt loam and loam are found. The usual type, however, is the shale loam.

The five types just mentioned—shale loam, stony loam, sandy loam, silt loam, and loam—have been mapped. A brief description of each follows.

The surface soil of the Berks shale loam consists of 6 to 8 inches of a brown or yellowish-brown loam or silty loam containing 40 to 70 per cent of small thin shale flakes and fragments. The subsoil is of heavier texture, a silty clay loam or heavy silt loam of yellow color, with content of shale fragments increasing with depth until at from 15 to 20 inches it consists of a mass of more or less broken rock.

The surface soil of the Berks stony loam consists of 6 to 8 inches of a brown loam containing a high percentage of flaggy angular stone fragments. The subsoil is a yellow silty clay loam containing more rock than the surface.

The Berks sandy loam consists of 6 to 8 inches of a medium yellowish brown sandy loam to fine sandy loam, resting on a yellowish heavy sandy loam which grades below into lighter sandy clay loam. Both soil and subsoil contain quantities of rock fragments.

The Berks silt loam consists of 8 to 10 inches of brown or light-brown silt loam, resting on a yellow silt loam that grades with increasing depth into yellow silty clay loam. The usual large quantities of shale fragments are present in soil and subsoil, the content being larger in the lower part of the profile.

The Berks loam consists of 6 to 8 inches of a brown or yellowish-brown somewhat gritty silty loam surface soil resting on a yellowish rather gritty silty clay loam. With the exception of small areas near the heads of streams and the occasional seepage areas along the lower slopes of the hillsides, the Berks soils have excellent natural drainage. The exceptions noted cover a very small proportion of the total area of these soils and are of little importance.

Because of the topographic position and the nature of the soil itself these soils are very subject to damage by erosion. In fact, it is this active erosion, removing the fine material as fast as formed, that causes the soils to be so shallow and so filled with rock fragments. The hills wash very badly, and if care is not taken numerous gullies are formed. These enlarge rapidly, all the soil material being usually washed away down to the broken rock mass. Great care is necessary to prevent these losses of the fertile soil, and contour farming, the leaving of strips of sod across the slopes, and even terracing on the steeper hills, should be followed more generally.

The soils have a low water-holding capacity, and crops suffer severely during droughts. The shale loam suffers most in this way, the loam and silt loam, with a deeper soil mass, being able to retain more moisture for the use of the plants. In some dry years the crops on the shale loam are almost a total loss.

The Berks soils are devoted to the general farm crops of the region. Fruit is grown to a considerable extent, apples and peaches doing very well. Near the larger towns some trucking and market gardening is done.

Dauphin and Lebanon Counties.—In Dauphin and Lebanon Counties the Berks soils occupy a broad area from 6 to 10 miles wide, occupying the northern half of the Lebanon Valley. The soils extend from the Blue Mountain on the north to the limestone valley, the southern boundary being roughly on a line drawn through Meyers-town, Lebanon, and Hummelstown to the river south of Harrisburg. The country occupied has a rolling to moderately hilly topography, with some elevated undulating areas. The shale loam and sandy loam are the only types found, the latter occurring as an elevated strip extending from near Jonestown, in a disconnected series of

areas nearly to Harrisburg. Practically all of the area is in farms, with some small forested areas on the lower slopes of the mountains, and the usual areas of farm woodlots. The soils are locally known as "gravel land" or as "slate lands." They are devoted to general farming, corn yielding 35 to 60 bushels, oats 35 to 60 bushels, wheat 20 to 30 bushels, potatoes 125 to 175 bushels, and hay from 1 to $1\frac{1}{2}$ tons per acre. Some tobacco is grown, the quality being good, but the yield much smaller than on the limestone soils.

Fruits do very well, some very successful commercial orchards being found. Near Harrisburg small fruits, strawberries, and garden truck are grown successfully. Land values vary considerably. Near the cities and along trolley lines the land is held at well over \$100 an acre, but the prices of purely agricultural areas range from \$45 to \$75, probably averaging about \$60 an acre.

Berks County.—In Berks County the area of Berks soils widens out considerably, attaining a maximum width of 16 miles west of Reading. The soils cover over one-third of the total area of the county, the shale loam being the predominating type. The areas are for the most part steeply rolling to hilly. The topography of the silt loam, of which one large area occurs northwest of Womelsdorf, is less hilly than that of the other types. The sandy loam, the largest areas of which are found in the southern part of Upper Bern Township, is more hilly than the average, with some rugged hills too steep to be cultivated.

With the exception of the steep slopes, which are usually wooded or in pasture, and the woodlots, the whole area is in farmed land. The general farm crops are grown. A considerable acreage is given to potatoes. Yields are highest on the silt loam, but the crop is not grown to any extent on this soil. The average yields of the leading crops are as follows: Corn 30 to 50 bushels, oats 25 to 50 bushels, wheat 15 to 25 bushels, potatoes 100 to 200 bushels, rye 15 to 25 bushels, and hay 1 to $1\frac{1}{2}$ tons per acre. The yields depend a great deal on the seasons. With plenty of rain during the period of growth the yields will equal or exceed the highest given, while in a dry season the crops may prove an absolute failure. The general rotation is corn, oats and potatoes, wheat and grass. The combined acreage of oats and potatoes usually equals that of corn. Grass is usually left down two years. Where potatoes are a leading crop, a shorter rotation is used. This usually is potatoes, wheat, clover, the latter crop being left one or two years. Where potatoes are the leading crop large quantities of manure and fertilizers are used and the soils are in an excellent state of productiveness.

The soils are low in organic matter, and are also benefited by applications of lime. The latter material is in quite common use over the county.

The Berks soils in Berks County vary in value, ranging from \$30 to \$65 for the shale loam, \$15 to \$45 for the sandy loam, and \$50 to \$120 for the silt loam.

Lehigh County.—The Berks soils cover the northern third of Lehigh County, from the limestone valley north to the foot of Blue Mountain. The country occupied is hilly with many steep-sided ridges, especially in the central and southern part. Four types were found, the shale loam being most extensive, and the loam, silt loam, and stony loam occurring in small areas. The last is found on the crests of some of the higher ridges, while the loam and silt loam lie on the lower, gentler slopes, where less active erosion and some accumulation have resulted in a deep soil mass.

General farming is the type of agriculture followed. Corn yields from 30 to 70 bushels, oats 20 to 60 bushels, wheat 15 to 30 bushels, rye 15 to 30 bushels, and hay 1 to $1\frac{1}{2}$ tons per acre. Potatoes yield from 100 to 250 bushels per acre and are one of the most important crops in the county. This crop is generally heavily fertilized with manure and commercial fertilizers. Alfalfa does well where properly cared for, giving three cuttings of 1 ton each. Land values depend largely on location and condition of the farm, and vary from \$25 to \$100 or more an acre. A fair average would be around \$60.

Northampton County.—The Berks soils extend across Northampton County in a band 6 to 10 miles wide just south of Blue Mountain from the Lehigh River east to the edge of the glaciated region, west of Bangor. The soils occupy country of steeply rolling to hilly topography and are subject to serious damage by erosion. They are low in organic matter, the need for that material being their most evident deficiency.

The shale loam is almost the only type, though small areas of silt loam and loam were found. The soils are farmed to the general crops of the region, corn yielding 30 to 60 bushels, oats 25 to 50, wheat 15 to 25, potatoes 100 to 200 bushels, and hay from three-fourths to $1\frac{1}{4}$ tons per acre. Corn, oats, and potatoes, wheat and grass, is the general rotation. The manure produced on the farm is used, but green manuring is not generally practiced, though it would be beneficial. Lime is used extensively and is of great benefit, especially where the land is to be seeded in clover. All crops suffer severely during dry seasons.

Land values vary, ranging from \$50 to \$100 an acre. The presence of the numerous slate quarries and the possible value of the land for quarry sites has caused the higher price of land in this county. On a strictly farming basis the price runs from \$40 to \$60 an acre.

Lancaster County.—In Lancaster County the Berks soils occupy a large body, lying north of the limestone valley and extending from

Rheems, past Manheim to Schoeneck, with a smaller area swinging south of Manheim, past Lititz, to Ephrata. There are also some smaller detached areas in the limestone valley south of these bodies. The soils occupy steeply rolling uplands, elevated 100 to 200 feet above the floor of the adjacent valleys, with abrupt slopes up from those valleys.

The shale loam is the prevailing type, though there are a few small areas of silt loam. The soils are shallow and crops suffer severely during dry seasons. On the slopes erosion is severe, if care is not taken to prevent it. The soils, as compared with the neighboring limestone lands, are not very productive, yet good yields of the general farm crops are obtained. Yields are 20 to 25 per cent lower than those on the limestone soils, but the difference in values is even greater, prices varying from \$60 to \$125 an acre, depending on location and condition of the land, buildings, and other improvements.

The soils give better results with potatoes than do the limestone soils. If the organic matter is kept up, either by the use of barnyard manure or by plowing under of green cover crops, very good yields can be obtained. Potatoes generally yield from 75 to 150 bushels, but 200 bushels an acre can be produced. Corn and small grains do not yield as well as on the limestone soils. Hay yields three-fourths to $1\frac{1}{2}$ tons, corn 30 to 50 bushels, wheat 15 to 25 bushels, and oats 35 to 60 bushels per acre. In dry seasons the yields are light.

The soils are adapted to fruit growing, and increasing acreages of peaches and apples are being set out. Bush fruits and strawberries also do well.

York County.—The Berks series is represented in York County by the shale loam and loam. The main body of the loam lies in the York Valley, between Wrightsville and Hanover. The topography is gently undulating. The type is devoted principally to general farming, with dairying as an adjunct. The yields of corn, oats, wheat, and hay are generally good. The price of the land varies from about \$75 to \$125 an acre.

The important area of the shale loam occurs in a belt of hills extending across the county on the east side of the York Valley. This belt varies from 2 to 5 miles in width. The surface is hilly and the drainage is thoroughly established. About 80 per cent of the type is farmed, principally to corn, wheat, and hay. The yields are fairly good. Some orchards of apples and peaches are giving good returns, where properly cared for. Irish potatoes do very well. Some tobacco is grown in the eastern part of the county, but the yields are lower than on the Hagerstown soils.

The valuation of land of the Berks types ranges from \$40 to \$75 an acre.

MONTALTO SOILS.

The Montalto types have reddish-yellow to brown colored surface soils and yellowish-red or dull-red subsoils, usually of clay loam or moderately friable clay. All types contain angular rock fragments of varying sizes from small gritty particles to fragments 2 or 3 inches in diameter. The soils are locally known as "ironstone land."

This series is not extensively developed, being found in small, rather scattered areas. It occurs in Berks, Lehigh, York, Lancaster, and Northampton Counties. The areas in the last two counties are extremely small.

The soils occupy a rolling to hilly country, being typically found on the slopes and foothills of South Mountain. They are derived chiefly from igneous rocks or trap rocks, such as diabase.

These soils are normally well drained, though there are some seepage areas on the lower slopes of extensive areas. The soils hold moisture well and crops are not ordinarily injured by droughts. Erosion is active over most of the area but is not severe.

The stony loam type is the most extensive, though a few areas of loam are found.

The surface soil of the stony loam consists of 6 to 8 inches of brown or reddish-yellow heavy loam, resting on a red or yellowish-red moderately friable clay loam or clay subsoil. The texture of the surface varies somewhat, in places being rather silty and in others rather gritty or sandy. Both soil and subsoil contain a large proportion of angular sharp-edged rock fragments of all sizes, while the lower subsoil frequently contains much partially decomposed rock. In places the soil is merely a mass of rock fragments, with a small quantity of fine interstitial material.

The loam consists of 6 to 10 inches of brown or yellowish-red gritty loam, resting on a reddish-yellow heavy loam, which grades downward into reddish clay loam or red clay. The soil and subsoil contain considerable sharp grit and some stone fragments.

The Montalto soils are quite productive.

Berks County.—In Berks County the Montalto soils occur in four areas, in Spring, Cumru, Exeter, and Washington Townships, in all of which they occupy rolling to hilly country. The stony loam is the only type found.

Geib, in the Berks County survey, reports as follows:

The Montalto stony loam is devoted to general farming, though there are some portions of the type which are too steep to be cultivated. It is considered a strong soil, and in the well-farmed localities the corn yields average about 40 bushels per acre, wheat 18 bushels, oats 35 bushels, and hay 1½ tons per acre. The type is well adapted to apples, peaches, and grapes, and the fruit industry should be extended. Farms on the Montalto stony loam range in value from \$20 to \$65 an acre, depending on location, topography, and improvements.

Lancaster County.—A very small area of the Montalto stony loam extends into Lancaster County just south of Adamstown. This is the western end of the Berks County area and is essentially the same in character. The larger part of this area of Montalto has not been cleared but is in forest or pasture.

York County.—There are a number of areas of Montalto soils in the rolling to hilly country in western York County. The soils are here well drained and on the steeper slopes suffer somewhat from erosion. The stony loam, stony clay loam, and clay loam are found.

The soils are productive and seem to be especially adapted to peach growing, some excellent orchards of this fruit being located on Montalto areas. Wheat and grass do well.

Lehigh County.—In Lehigh County there are several small areas of Montalto, nearly all of the stony loam type. These occupy hilly country typical of the series and are considered quite productive. The special adaptation of these soils to fruit growing has not been appreciated here.

Northampton and Bucks Counties.—In Northampton and Bucks Counties there are a few small areas of Montalto soils, those in Bucks County being too small to be shown on the map. In all these areas the stony loam is almost the only type found. The soils where cleared are devoted to the general farm crops, with fairly good yields.

HAGERSTOWN SOILS.

The Hagerstown soils have a yellow or reddish-yellow surface soil and a yellow, yellowish-red, or red subsoil. The soil material is derived from massive limestones. These soils are found in 14 of the 19 counties included in this survey, but are extensively developed in only 8.

The Great Valley, or Cumberland Valley, of which the western section was mapped in Cumberland and Franklin Counties in 1910, extends across the Susquehanna River at Harrisburg and in a widening belt across Dauphin and Lebanon Counties. The valley narrows in Berks County, but widens again beyond Reading, crossing Lehigh and Northampton Counties and passing out of the area into New Jersey. It is one of the most extensive belts of highly productive soils in the State.

Another outcropping of the limestone starts in Adams County, extending across York County in a narrow, irregular band and expanding in Lancaster County to cover a large part of the central and northern sections. One small arm reaches into southern Berks County, and another detached arm extends across Chester into Montgomery County as the narrow Chester Valley. The limestone soils of Lancaster have given that county a very high reputation as the richest and one of the most productive counties in the State. The

limestones occur in two small valleys in Bucks County and in narrow outcrops and ridges in Northumberland, Montour, and Columbia Counties. In the three latter counties the Hagerstown soils are derived from the Lower Helderberg limestone¹ and usually occur on narrow ridges and low, rounded hills. The outcrop of this formation is very narrow, and in many cases the strips of soil were too narrow to be shown on the map. The Lower Helderberg outcrops also occur in Schuylkill, Carbon, and Monroe Counties, but are very narrow, and practically no Hagerstown soils are found. One small area was mapped in Monroe County.

With the exceptions just noted, the Hagerstown soils are all derived from the weathering of limestone² of Cambrian or Cambro-Ordovician age. These limestones are relatively pure and massive and are weathered by the solution and removal of the calcium carbonate, the residual impurities forming the soils. The Hagerstown areas occupy gently rolling to moderately rolling lowland belts which lie at elevations of 100 to 200 feet or more below the country occupied by the adjoining shale and sandstone soils. Where the rock has been much folded, the exposure of layers of varying hardness and purity, with different rates of weathering, gives a topography marked by low ridges, with irregular outlines and abrupt changes of slope. The typical topography is that of a rolling depression.

The soils do not suffer much from erosion, and it is only on the steeper slopes that washing causes any appreciable damage.

As a whole, the Hagerstown soils are well drained. There are a few areas where artificial drainage would be beneficial, but over most of these soils the rains soak readily through the soils, the excess water escaping downward through underground channels dissolved in the rocks. It is rare that water will stand on the surface of the limestone soils for more than a few hours after the heaviest rain, and ponds or pools are seldom found. Sink holes are a typical feature of the Hagerstown landscape.

With this exceptionally active drainage, the soils are not droughty. The large percentage of silt and clay, especially the latter, in the subsoil gives a soil of high capillary power and water-holding capacity. With care to reduce evaporation losses by cultivation, crops can be carried through any but the most severe droughts without serious reduction of yield.

There were five types of these soils found, the clay, stony clay, clay loam, stony loam, and loam.

The Hagerstown stony clay consists of 2 to 6 inches of dark-red or brown heavy clay loam or clay resting on a stiff red clay subsoil. The soil and subsoil contain 30 to 60 per cent of angular limestone fragments.

¹ Second Pennsylvania Geological Survey

² Loc. cit.

The Hagerstown clay consists of 2 to 6 inches of dark red or reddish-brown heavy clay loam resting on a stiff red clay subsoil.

The Hagerstown clay loam consists of 6 to 10 inches of a brown or yellowish-brown silty loam or silty clay loam, resting on a heavy yellow to reddish-yellow silty clay loam which grades into a stiff red clay at 20 to 24 inches.

The surface soil of the Hagerstown stony loam is a brown or yellowish-brown silty loam, 6 to 8 inches deep. The subsoil is a yellow or reddish-yellow silty clay loam grading downward into a stiff red or yellowish red clay. On the surface and through the soil mass are found large quantities of angular chert and limestone fragments.

The Hagerstown loam consists of 8 to 10 inches of a brown or yellowish-brown silty loam, resting on a light yellowish brown silty clay loam which grades with depth into a stiff red clay or clay loam.

The Hagerstown soils, taken as a whole, are the most productive in the State. They are well adapted to the general farm crops. Tobacco is an important special crop in some counties.

Dauphin County.—The belt of Hagerstown soil in the Great Valley section of Dauphin County is not wide, and is divided west of Hummelstown into two arms, one reaching west of Harrisburg, the other southwest to High Spire. East of Hummelstown the belt broadens rapidly, attaining a width of about 4 miles at the Lebanon County line. It occupies the undulating sides of a shallow valley, and has a gently sloping surface. The loam of the series is the only type found in Dauphin County.

Practically all of the land is tilled, the exceptions being small areas in woodlots and some areas where rock outcrops are numerous. The soil is devoted mainly to the general farm crops. A few truck farms and market gardens exist. The soils are very productive. Corn yields 80 to 100 bushels shelled, oats about 50 bushels, wheat 25 to 35 bushels, and hay 1 to 2 tons per acre. Most of the farms have large dairies and silos are in common use. The land is valued at \$125 to \$200 an acre.

Lebanon County.—The belt of Hagerstown soils broadens out in Lebanon County to attain a width of 5 to 7 miles, reaching across the county from west to east. The area has a gently rolling to somewhat hilly topography, the hills being low, but with rather abrupt changes in slope. All of the land is in cultivation, except the occasional areas where rock outcrops are numerous, which are used as pastures, and the small areas reserved as woodlots. The loam is the predominant type, with some small areas of clay and some stony ridges and slopes.

The soils are devoted to the general farm crops—corn, oats, wheat, and grass. Dairying is the principal farming industry. Considerable tobacco is grown, practically all of the broad-leaf filler type. Tobacco yields 1,200 to 1,800 pounds, corn 40 to 60 bushels, oats 40 to

60 bushels, wheat 25 to 35 bushels, and hay 1½ to 2 tons per acre. Alfalfa is grown to some extent, three cuttings usually being obtained.

Lime is needed to secure the best results, and is in common use. Fertilizers are commonly used and manure is generally carefully saved and applied on the corn and tobacco land. Farm buildings and other improvements are of the best kind and farmers are quite prosperous. Prices of land of this series are high, ranging from \$100 to \$200 or more an acre.

Berks County.—The belt of Hagerstown soils that crosses Lebanon County narrows abruptly in Berks County, ending just east of Womelsdorf. The limestone outcrops begin again in Lower Heidelberg Township, widening out eastward until a width of 3 or 4 miles is reached at Reading. At this place the valley of Hagerstown soils bends north for several miles, then turns east and northeast across Maiden Creek, Richmond, Maxatawny, and Lower Swamp Townships, maintaining an average width of about 4 miles. East of Reading, in Oley Township, Oley Valley spreads out as a very fertile Hagerstown loam section.

Berks County Hagerstown areas are usually gently rolling to rolling, with a few of hilly topography, where the stony loam and clay loam types are found. These two types are, however, of little extent, the loam being the dominant soil. Along the edges of the valleys, where the limestone joins the sandstone and metamorphic rocks, the soils are somewhat lighter and contain more sand and grit than is typical.

Nearly all of the Hagerstown soils are cleared and in farms. The loam is considered the strongest and most productive soil in the area. The soils are devoted mainly to general farm crops, but a small acreage is in tobacco. The latter crop is grown chiefly in the southwest corner of the county, in Caernarvon Township, in the extension of the Lancaster limestone area. Corn averages 50 bushels, oats 45 to 50, wheat 25 to 30, and hay 1½ tons per acre. Rye is grown to some extent, yielding 20 to 25 bushels per acre. Land values range from \$75 to \$175 an acre, depending on location and improvements. Manure and fertilizers are extensively used, the latter usually being applied to the wheat fields. Lime is in common use.

Lehigh County.—The Hagerstown soils spread out in Lehigh County, crossing it in a belt varying in width from 4 miles at the Berks County line to more than 8 miles at the eastern side along the Lehigh River. Another area, with an extent of about 10 square miles, lies in the southeastern part of the county in Saucon Valley. The areas have an undulating to rolling topography, with a few steep slopes along the streams. Drainage conditions are good, though the soils are not droughty. The loam is the prevailing type, with small areas of silt loam and stony loam. Practically all of this area is in farms, except

the stony loam, which occupies the steepest hillsides and is generally wooded. The soils are devoted to general farming crops, corn, oats, wheat, and grass, with some potatoes, rye, and alfalfa. Corn yields 40 to 90 bushels, averaging 60 bushels; oats 30 to 60 bushels, averaging 50 bushels; wheat ordinarily about 25 bushels, hay 1½ to 2 tons, rye 15 to 25 bushels, and potatoes 150 to 200 bushels per acre. Alfalfa is grown on a few farms, giving yields of three-fourths to 1 ton per cutting, three cuttings being obtained each year. Commercial fertilizers are in general use, especially in growing wheat, and barnyard manure is carefully saved and applied to the land. Lime is used regularly, being applied every 5 to 8 years, or once during each rotation period. Land values range from \$75 to \$200 an acre for the loam and somewhat less for the silt.

Northampton County.—In Northampton County a belt of Hagers-town soils 6 to 8 miles wide crosses that part of the county lying north of the Lehigh River. Another area lies beyond the mountains south of Bethlehem, to the north and west of Hellertown, and a third along the Delaware in the southeast corner of the county, in Williams Township.

The soils occupy generally a country of gently rolling topography and have good natural drainage. Practically all of the land is cultivated, the general farm crops, corn, oats, wheat, rye, and grass, being grown. More wheat is grown than usual on the farms of this State. Wheat is put in the rotation after corn and oats, and also after clover, about twice as much wheat being grown as of corn and oats. Grass is seeded with the wheat and usually left for two years. Considerable stock is kept, dairying being the dominant type of farming.

The loam is the principal type found, but small areas of clay loam also occur. A phase of the loam occurs in a strip 2 or 3 miles wide, extending from Martin Creek to Easton. Here the soil contains an appreciable amount of sand to a depth of 6 to 8 inches, making it lighter and easier to work than the typical soil. This phase is used chiefly for general farming, but there is a relatively large area devoted to trucking and market gardening. This phase, because of its location and its adaptation to trucking, is valued higher than the typical loam. It is held at \$100 to \$150 an acre. The loam, farther from towns, sells for \$75 to \$125 an acre, averaging about \$100. Crop yields are high. Corn yields about 75 bushels, oats 40 to 50, wheat 25 to 30, rye 18 bushels, potatoes 100 bushels, and hay 1 to 2 tons per acre.

Lime is of great benefit to these soils and is in general use. Stable manure or green manures give good results, and the former is carefully saved and applied to the land. Commercial fertilizers are in common use.

Lancaster County.—The Hagerstown soils make up the larger part of the justly famed limestone lands in Lancaster County. These soils occupy a large proportion of the northern part of the county, extending east from Bainbridge and Marietta on the Susquehanna River, in a belt from 6 to 12 miles wide. East of Lancaster the belt is divided by the Welsh Mountains, the southern arm extending almost to the Chester County line and the northern arm extending beyond the county line into Berks County. North of this main valley is another large Hagerstown area, extending from Manheim, past Lititz, to spread out in a broad area north and east of Ephrata. Southeast of Columbia is a small area, inclosed in the hills, and in Bart and Sadsbury Townships occurs a narrow strip, representing a western extension of the Chester Valley.

The soils have a level to gently rolling topography, with a few steep areas near the mountains. The loam is the most extensive type, though considerable areas of clay loam and some small areas of clay also are found. The areas have excellent natural drainage, and the whole region is marked with sink holes, through which the excess water escapes. Practically all of the Hagerstown area is in farms, in the broad belts, especially, there being very little waste land. The farms are in excellent condition, with good buildings and other improvements. General farm crops are grown, and tobacco is one of the principal money crops. In 1909 Lancaster County had 32,783 acres in tobacco, producing a total of 36,892,869 pounds. Ordinarily the yield of tobacco ranges from 1,000 to 1,800 pounds per acre. The tobacco is all of the broad leaf filler type. Tobacco land is fertilized, heavy applications of manure being applied.

Dairying is an important farm industry in the county, butter and cheese being sold in the Lancaster markets, and large quantities of whole milk in Lancaster or the other towns. Some milk is shipped to Philadelphia and Reading.

The general farm crops yield well, corn averaging 80 to 100 bushels, oats 50 to 60 bushels, wheat 25 to 30 bushels, and hay 1½ to 2 tons per acre. Alfalfa is grown to some extent, good results being obtained where it has been properly seeded and cared for.

Land values over the area are high, ranging ordinarily from \$120 to \$200 an acre. Near Lancaster and the larger towns prices are even higher than the maximum stated above.

The Hagerstown soils in this county probably make up the most productive single body of soils in the State.

Chester County.—In Chester County the Hagerstown soils extend in a single belt from the Lancaster County line west of Atglen, throughout the length of the Chester Valley, becoming broader to the east and having a width of over 2 miles where it enters Mont-

gomery County. The soils occupy moderately rolling country, with some broad, rounded hills, and flat-topped ridges. The loam is the only type mapped in the county. The soil varies considerably, in some places being much lighter than typical, and in others containing considerable quantities of mica fragments, especially in the lower subsoil. The soil has good natural drainage and is not subject to severe erosion, though on some of the steeper slopes some drainage results from this cause. The areas are devoted to general farm crops with good returns. Corn yields 75 bushels, oats 40 bushels, wheat 28 bushels, potatoes 150 bushels, and hay 2 tons per acre.

Montgomery County.—The Hagerstown soils occur in one area in Montgomery County, extending along the eastern end of the Chester Valley from near Valley Forge through King of Prussia, east nearly to Willow-Grove. The soils occupy a rolling to somewhat hilly lowland inclosed by higher hills. The loam type is the only one encountered, though there is some silty loam and some fine sandy loam in small areas in the western part of the valley. The soils are well drained. On the steeper slopes the run-off is sufficient to cause erosion. That the soils are well adapted to the general farm crops is attested by the yields obtained. Ordinarily yields of 100 bushels of shelled corn, 35 bushels of oats, 25 bushels of wheat, and 1½ tons of hay are obtained on the well-farmed areas. The land is valued at \$100 to \$125 an acre.

Bucks County.—In Bucks County the Hagerstown soils are found in two areas, one extending as a belt 1 to 1½ miles wide across Buckingham and Solebury Townships in the central part of the county, the other extending across Springfield and Durham Townships, in the northeastern corner of the county. The soils occupy rolling to somewhat hilly country, with some rather steep slopes. They are well drained. Cultivated fields suffer somewhat from sheet erosion on the steeper slopes, but do not gully readily.

Practically all of the land is in farms, the steeper slopes being used for pasture. The general farm crops are grown, with good yields. The land values vary from \$65 to \$75 an acre. The soils are heavier than those in Montgomery and Chester Counties, the loam and clay loam being the only types of any extent.

York County.—In York County the loam and clay loam of the Hagerstown series are found. They occur in the York Valley, and the former type is comparatively extensive. Both of these are productive soils, giving good yields of corn, small grains, clover, and tobacco.

Northumberland and Montour Counties.—The Hagerstown soils occur in several small areas in Northumberland and Montour Counties, the most extensive area lying in Limestone Township, in the

latter county. The soils occupy narrow ridges, and in places rolling to hilly uplands. The soils are derived from the weathering of the lower Helderberg limestone, which outcrops as a series of narrow stony ridges. In Northumberland County small areas of Hagerstown soils were mapped in Lower Mahanoy, in Chillisqueque, Delaware, and Lewis Townships, while in Montour County, besides the large area in Limestone Township, there are small occurrences in Liberty and Cooper Townships. The stony clay, clay, and stony loam types are most common, with some loam in the large area in Montour County. The soils are devoted to pasture and to general farm crops. Some excellent farms are found in the large area in Montour County, but the other areas are of little importance except as a source of limestone and lime.

Columbia County.—The Hagerstown soils occur in only two small areas in Columbia County, and are of little importance except as a source of limestone for burning or for road surfacing. The outcrops are narrow and the resulting soils usually stony clay or a rather stony, silty loam.

Monroe County.—In Monroe County there is one small area where the limestone outcrops sufficiently to form a distinct soil. The area lies southwest of Stroudsburg, near Bossardville. The whole section has here been glaciated, but the glacial material has almost wholly been removed by subsequent erosion, and the soils are practically identical with the Hagerstown. The stony clay, and a rather stony, silty loam are found. The soils occupy the top and sides of a rounded hill or knob. The occurrence of limestone here and farther along the valley, even where it does not apparently affect the soils, has been of great importance economically, as it has furnished a local source of lime for agricultural use, the need for lime in other soils in the region being very marked.

CONESTOGA SOILS.

One type in the Conestoga series, the loam, is found in Lancaster, Montgomery, and York Counties. This soil is derived from rather impure schistose limestones. The surface soil consists of a yellowish-brown loam, 10 to 12 inches deep. The subsoil is a yellow loam or light clay loam which grades into partially decomposed limestone schist at 28 to 30 inches. The subsoil material often has a greenish cast. Both soil and subsoil have a distinctly greasy feel when rubbed between the fingers, due to the presence of finely divided mica particles.

The Conestoga loam occupies more steeply rolling country than do the Hagerstown soils. The type has good natural drainage, though sink holes are rarely if ever found in the Conestoga soils, and

the subterranean drainage typical of the Hagerstown soils does not exist. On the steeper slopes considerable damage is done by sheet washing and gullying.

The soil dries out quickly in the spring, and can be worked earlier than the Hagerstown soils. It is not so retentive of moisture, however, as the latter, and crops suffer more during periods of drought.

Montgomery County.—In Montgomery County the Conestoga loam occupies less than 2 square miles, occurring in one large area near Conshohocken. It is devoted to farming and gardening. Over half of its area lies within Conshohocken and its suburbs.

Lancaster County.—In Lancaster County the Conestoga loam occupies a large area, lying south of Lancaster in a large body extending from the Susquehanna River east nearly to Gap. Some smaller areas occur near Quarryville and a narrow belt extends east along the Chester Valley.

The Conestoga loam occupies gently rolling to somewhat hilly country. The areas are more hilly near the streams and on the south, where they adjoin the hilly Manor soils. This soil is almost wholly in farms, and is devoted to the general farm crops and to tobacco. It is not as strong as the Hagerstown soils, but is earlier and is more easily worked. It is greatly benefited by stable manure and green manuring crops. Lime is needed for best results, and is in very general use. Land values vary considerably, ranging between \$100 and \$200 an acre, depending largely on location and character of improvements. Crop yields are high, corn averaging 50 to 60 bushels, wheat 25 to 30, oats 35 to 50, and hay 1½ to 2 tons. Tobacco produces from 1,200 to 1,600 pounds or more per acre.

York County.—The Conestoga loam occurs in York County as a fair-sized body in the vicinity of East Prospect. It is a well-drained soil with rolling surface, and is largely under cultivation. Corn, wheat, oats, hay, and tobacco give nearly as large yields as those obtained from the Hagerstown loam. The type constitutes a valuable soil.

FRANKSTOWN SOILS.

The Frankstown series is represented in the present survey by one type, the stony loam. The soil is derived from the impure limestones associated with the Lower Helderberg formation and occupies the tops and sides of a double-crested ridge. The soil contains a large proportion of small angular chert and limestone fragments, with sharp edges and corners, in places being made up almost wholly of these fragments. The surface soil has a grayish-brown or ashy-brown color, and rests on a gray or ashy colored subsoil. The surface soil is quite silty, but is so full of small chert fragments that it has a gritty feel. The subsoil is a rather gritty, silty clay loam.

Northumberland County.—One small area in this survey occupies a ridge in southwestern Northumberland County in Lower Mahanoy and Jordan Townships. The larger part of the Frankstown stony loam is cleared and in farms, but there are some wooded areas on the crests and slopes of the ridges. The soil is devoted to general farm crops, good yields of which are obtained. Some fruit is also produced. The soil is well drained and does not suffer severely from ordinary droughts. Land values average about \$45 an acre.

There are some extensive occurrences of the Frankstown stony loam in the counties west of the Susquehanna, mapped in 1910,¹ and there the soil was found to be very well adapted to apple growing. It is probable that apples would do equally as well on the area in Northumberland County.

ATHOL SOILS.

The soils of the Athol series are brown to reddish brown in color, and the subsoils light brown to reddish brown. They include some material having the characteristics of both the Penn and Hagerstown soils, such areas being locally called "all sorts land." The soils are derived from a limestone breccia, including fragments of limestone and gray and red sandstone. This formation is known as Potomac marble. The content of lime is high enough to warrant burning for lime.

Berks County.—The Athol loam occurs in Berks County. Under cultivation it is easy to handle, and works up readily into a mellow seed bed. Numerous rock outcrops throughout the type and a few stones upon the surface in places interfere somewhat with cultivation, but practically all of the type is under the plow. The largest area, which covers several square miles, is found in the northern part of Amity Township. Another area extends eastward from Klappert-hall for about 3 miles, and westward across the Schuylkill River for about $1\frac{1}{2}$ miles. Another small body occurs between these two. The surface is gently to moderately rolling, and the natural drainage good.

All the crops common to this region are successfully grown upon the Athol loam, and it is considered a good general farming soil. It is held by some to be nearly equal to the Hagerstown loam, but on account of numerous rock outcrops the yields are somewhat lower. Wheat yields from 12 to 28 bushels per acre, with an average of about 20 bushels, corn from 30 to 50 bushels, and oats about 38 bushels per acre. It is reported that on a portion of the type clover does not do especially well, but timothy thrives and yields from 1 to $1\frac{1}{2}$ tons per acre. The farms on this type range in value from \$60 to \$100 an acre.

¹ Reconnaissance Survey of South-Central Pennsylvania.

York County.—In York County a few patches of Athol clay were mapped in the western part of the area. The type is a good general farming soil.

DECATUR SOILS.

The Decatur soils are residual from limestone. They are characterized by the reddish-brown color of the surface soil and the deep-red color of the subsoils, as distinguished from the brown surface soil and reddish-brown subsoil of the Hagerstown series.

Only the clay loam was mapped in this survey. It consists of a reddish-brown to red clay loam underlain by red brittle clay. The soil is well drained and is topographically suited to agriculture.

York County.—The Decatur clay loam was mapped only in the York Valley of York County where it occurs in small areas. It is adapted to about the same crops as the Hagerstown clay loam and gives about the same yields.

HANCEVILLE SOILS.

The Hanceville soils are grayish to brownish soils underlain by brick-red material, usually clay. They are characteristically residual from brown sandstone and shales and quartzite, representing the red subsoil series equivalent of the Dekalb. The soils are well drained and are somewhat more productive than the corresponding members of the Dekalb series.

In this survey the gravelly loam is the only member of the series mapped. The type consists of brownish gritty loam, underlain at about 12 to 14 inches by brick-red clay. Angular quartzite fragments are sufficiently abundant to give the soil a decidedly gravelly character. This is derived from sandstone and quartzite, being in part colluvial. The soil is well drained.

York County.—The Hanceville gravelly loam occurs in small bodies on the slope of South Mountain in York County. It gives fairly good yields of wheat and corn.

ASHE SOILS.

The Ashe soils which typically occur in this region of crystalline rock of the Appalachian Mountains are characterized by the grayish to brownish color of the surface material and by the yellowish color of the subsoils. The material, in case of the silty clay loam, the only type mapped in this survey, is residual from metamorphic rocks. The type consists of brownish silty clay loam, underlain by yellowish-brown or yellow silty clay.

York County.—The Ashe silty clay loam occurs in the western part of York County in rather small bodies. Where the surface is not too rough it is capable of giving good returns with corn, small grain, grass, potatoes, peaches, and apples.

EDGEMONT SOILS.

The Edgemont soils represent the yellow subsoil equivalent of the Herndon, or what might be considered the Piedmont equivalent of the Dekalb. They occur typically as rough ridges and hills which stand up conspicuously in the Piedmont section. The surface soils are gray and the subsoils yellow. The material is residual chiefly from quartzite. These soils are well drained. They are rather low in agricultural value.

York County.—The stony loam and loam occur in York County, the former extensively. Much of the stony loam, which occupies high ridges, is topographically unsuited to agriculture, except for the growing of fruit. In addition the stone fragments serve to make cultivation difficult. Most of this type is timbered. The loam gives fair crops of corn and small grain.

CHESTER SOILS.

The Chester soils make up one of the most important and extensive series in the Piedmont region of Pennsylvania. The surface soils are typically of brown or yellowish-brown color, and the subsoils yellow, though the subsoil of the heavier types is quite reddish and often grades into a red clay loam or clay within the 3-foot section. This variety of material, however, represents a phase condition.

The Chester soils are found in every county in the Piedmont section of the State, but are most extensively and typically developed in Chester and Delaware Counties. The soils are derived from igneous and metamorphic rocks, principally from gneiss and mica schists, with considerable areas from gabbro and other granitic rocks. The soils occupy rolling to hilly country, with some areas in the more northern counties that approach the mountainous in character. In Chester, Montgomery, Delaware, Philadelphia, and southern Bucks Counties the soils occupy a rolling to hilly country, with many steep slopes, but with few rugged areas. In Berks, Lehigh, Northampton, and northern Bucks Counties the Chester soils are prevailingly hilly to somewhat mountainous in character and with many areas of rough stony land unfit for agricultural purposes. In these counties the soils are derived largely from the granitic rocks, while in the first-named counties they are derived from the schists and gneisses.

Drainage conditions are usually good, though there are some small areas along the foot of the hills that may need artificial drainage to secure the most satisfactory results. The soils, because of their topography, are quite subject to erosion, and on the steeper slopes there is a tendency to gully. The greater damage is done by sheet erosion, and it is desirable that contour farming be practiced on the steeper slopes, and if necessary, strips of sod be left across the slopes.

Usually little or no attention is paid to this erosion, and in most cases the losses from this cause are not appreciated.

Four types have been recognized in the Chester series—the loam, stony loam, fine sandy loam, and mica loam.

The surface soil of the Chester loam consists of 8 to 10 inches of a brown mellow loam, containing some gritty material, resting on a subsoil consisting of a brownish-yellow gritty loam which in many places grades into a reddish-yellow silty clay loam.

The surface soil of the Chester stony loam consists of 8 to 10 inches of a brown medium loam resting on a yellowish-red or reddish-brown clay loam which grades into a red clay within the 3-foot section. Both soil and subsoil contain a large number of angular rock fragments, and often the surface is strewn with such fragments mingled with bowlders.

The Chester fine sandy loam consists of a brown or yellowish-brown fine sandy loam from 8 to 10 inches deep, resting on a yellow fine sandy loam or fine sand. The subsoil often contains a large number of small rock fragments.

The surface soil of the Chester mica loam consists of a loose brown silt loam 8 inches deep, containing a large amount of finely divided mica particles. The subsoil consists of a yellow heavy silty loam, containing more mica than the surface soil and grading with depth into a mass of fine mica particles.

The Chester soils are well adapted to general farming and to dairying and give good results with potatoes and with fruit, especially apples. The general rotation practiced is corn, oats, and potatoes, wheat and grass two years, although this is varied somewhat to suit the local conditions.

Chester County.—The Chester soils cover over 46 per cent of Chester County, occupying the southern and eastern sections, and also a large area north of the Chester Valley. The soils occupy rolling to hilly country, the northern area being more hilly than the southern. The loam makes up about 90 per cent of the whole area of Chester soils, with stony loam next in importance, and a few isolated areas of fine sandy loam.

In the central part of the county occurs a finer, softer, more silty phase of the Chester loam, which is much more productive than the typical soil. The average yields of the loam, as given in the Soil Survey of Chester County, 1905, are as follows: Shelled corn 65 bushels, oats 40 bushels, wheat 25 bushels, potatoes 140 bushels, and hay 1½ tons per acre. The stony loam is reported to yield from 15 to 20 per cent less than the loam.

The soils are very well farmed in this county, which is one of the most progressive in the State. Manures and fertilizers are in general

use, and lime is used to a considerable extent. The general condition of the soils is good, and the farm buildings and general improvements are excellent. The Chester soils are valued at \$75 to \$150 an acre, with many farms held at higher prices. Good Chester loam, within easy hauling distance of a railroad or shipping point, can be purchased for \$100 to \$125 an acre, though land values are increasing yearly in this section.

Delaware County.—With the exception of two small areas and the belt of Coastal Plain soils along the Delaware, the Chester soils occupy all of Delaware County. The county has a rolling to somewhat hilly topography, the hills being rounded and rarely too steep for cultivation. The loam is the dominant type, covering fully 75 per cent of the Chester area, with the stony loam as the only other type present. Practically all of the land is in farms, though there are many farm woodlots, giving a considerable total area in forest. The soils are in good condition, as a whole, but there are many farms that have been purchased by real estate operators who are holding for a rise on land values, and other farms and groups of farms that are controlled or have been purchased by wealthy men in order to improve the fox-hunting conditions in the section. The farms in these classes are not well farmed, in many cases are not farmed at all, with the result that the land is becoming eroded and covered with weeds and the buildings falling into decay. The effect of these conditions has been very bad on the communities where they occur. Where properly farmed the Chester soils give excellent returns. Corn yields 75 to 100 bushels, wheat 25 to 35, oats 35 to 45, hay 1½ to 2 tons, and potatoes 100 to 200 bushels per acre. Dairying is one of the leading industries.

Land values vary greatly. In the strictly farming districts the price per acre ranges from \$75 to \$150, averaging about \$100 an acre. In some sections the steeper loam and stony loam areas can be bought for as little as \$40 or \$50 an acre, while near Philadelphia the price runs up into the thousands. Here many magnificent country homes have been built.

The Chester soils of Delaware County are more deficient in organic matter than in Chester County, and need manure or green manures to build up this constituent. Lime is needed for best results with the clovers and is generally in use. Fertilizers are in common use. Most of the soils are well drained, though there are frequently wet areas at the foot of the slopes, where seepage waters work to the surface.

Philadelphia County.—Practically all of the Chester area in Philadelphia County is occupied by city developments, and there is no real agricultural land, though north of Bustleton there are some excellent farms. Land values are based on city prices rather than on agricultural values.

Montgomery County.—The Chester soils cover about 15 per cent of Montgomery County, the loam being the principal type. The fine sandy loam, stony loam, and mica loam were also found. The soils occupy moderately to steeply rolling topography, with few slopes too steep for cultivation. The largest body of the soils lies in the southeastern section, next to Philadelphia County. The areas in the northern part of the county occur on ridges and have a much more broken topography than those near Philadelphia.

The soils are well adapted to general farm crops, giving yields of 60 to 75 bushels of corn, 20 to 25 bushels of wheat, 30 to 40 bushels of oats, 20 bushels of rye, 75 to 125 bushels of potatoes, and 1½ to 2 tons of hay per acre. For farming purposes the land is valued at \$100 to \$150 an acre, but owing to its nearness to Philadelphia most of it is held at much higher prices and is being sold for suburban homes and country estates.

The soils are somewhat deficient in organic matter and the fine sandy loam is inclined to be droughty. The soils are also somewhat in need of lime, especially the heavier phases of the loam.

Berks County.—In Berks County the Chester soils cover about 11 per cent of the county, the stony loam covering 10 per cent, or 64,000 acres, while the loam, the only other type, covers only about 2,000 acres. With the exception of an area west of Wernersville, all of the Chester soils lie on South Mountain east of Reading. The country is hilly, broken, and in sections somewhat mountainous, and includes besides the stony loam and small areas of loam considerable areas of Rough stony land. All of the soils are stony, the loam containing many stone fragments, especially in the subsoil. The loam has a more level or gently rolling topography than the other soils, but occurs in small, scattered areas. The stony loam contains a large quantity of small rock fragments, and in many places the surface is strewn with large, angular boulders, ranging up to several feet in diameter. Where the large stones are found the smaller ones are not numerous.

The soils are largely under cultivation, the general farm crops being grown. Wheat yields 18 to 20 bushels, corn 30 to 50, oats 25 to 50, hay from three-fourths to 1 ton, rye 18 to 25 bushels, and potatoes 75 to 150 bushels per acre. Stable manure and fertilizers are used to some extent. The stony loam is valued at \$25 to \$70 an acre, and the loam from \$45 to \$75 an acre.

The soils give good results with fruit, especially apples, and many new orchards are being set out.

Bucks County.—In Bucks County there is, west of Langhorne, an area of Chester soils which joins the area in southern Montgomery County. The soils occupy a rolling to hilly country. The loam type is the more extensive, the stony loam occurring only on the slopes.

In northern Bucks County the Chester soils occupy a series of hills and ridges and the south slopes of South Mountain, and the stony loam is the most extensive type, there being only a few areas of loam. Numerous areas of Rough stony land occur, especially on the steeper slopes. South of New Hope are two areas of Chester soils, consisting of stony loam with some Rough stony land, lying on the tops and sides of two sharp ridges.

In general the soils have good natural drainage, the slope giving rapid surface run-off and the high stone content giving a permeable subsoil that allows the water to sink in quite freely. Erosion is quite severe on the steeper slopes, though the presence of the numerous stones usually prevents serious washing. On the ridges in the northern part of the county, much of the Chester soil surface is covered with large angular boulders, 2 to 4 feet in diameter, these being often so numerous as to preclude the use of machinery and sometimes to prevent altogether the use of the soil except for pasture. Only about one-third of the northern area of Chester soils can be cultivated, the remainder being in forest or suitable only for use as pasture land.

The small orchards now existing on these soils are giving good returns, and the soil and climatic conditions are evidently favorable to fruit growing. Commercial orchards of apples, peaches, plums, etc., should prove profitable.

In the northern section corn, oats, rye, and grass are grown, yields being rather low. In the southern section the yields are much higher and wheat takes the place of rye in the rotation.

In the southern section the soils are worth from \$75 to \$100 an acre, but in the north the stony loam ranges from \$15 to \$50 an acre and the loam from \$50 to \$75. The future development of the soils to the north, undoubtedly, lies in the extension of the fruit industry.

Northampton County.—In Northampton County the Chester soils occur in one area in Williams Township, occupying a rough, hilly section of the eastern extension of South Mountain. The stony loam and Rough stony land make up the larger part of the area, though there are some small occurrences of the loam. As a rule the soils are well drained, and in many places the run-off is so rapid that gullies are formed. Not over one-half of the area can be tilled, the remainder being too steep or too stony for cultivation. The soils are devoted to general farming and pasture, with some fruit growing. The fruit industry could well be extended, as the soils are well adapted to the production of apples. Land values vary widely, ranging from \$20 to \$75 an acre. Lands suitable for farming are held at an average price of about \$50 an acre.

Lehigh County.—In Lehigh County the Chester soils are found on the tops and flanks of the South Mountains. The county has a rolling to hilly topography, with some areas rugged and almost mountainous

in character. The loam and stony loam are the only types found, the loam being the more extensive. Nearly all of this soil is in farms. A large part of the stony loam is forested, and much of it is too steep for cultivation. The soils are well drained and are farmed to the general crops. On the loam corn yields from 50 to 70 bushels, oats 30 to 60 bushels, wheat 18 to 25 bushels, rye 15 to 25 bushels, hay 1 to 1½ tons, and potatoes 75 to 150 bushels per acre. The yields on the stony loam are considerably lower. The soils are well drained and are somewhat subject to erosion. From \$25 to \$75 an acre represents the range in price of the loam. The stony loam brings from \$25 to \$50 an acre.

Lancaster County.—In Lancaster County the Chester soils occur in several widely separated areas. The area in the southern part of the county, in Fulton and Drumore Townships, has a rolling to hilly topography, and the loam is the dominant type, with small scattered areas of stony loam and fine sandy loam. The soils are almost wholly in farms, with the usual small woodlots.

In the central part of the county, in Sadsbury, Eden, and Strasburg Townships, the soils occupy steeply rolling to hilly topography, the Eden and Sadsbury section lying on the top and flanks of Mine Ridge. In these sections the stony loam is most extensive, with smaller areas of loam, fine sandy loam, and mica loam. There are also considerable areas of Rough stony land, occurring usually in small patches. Not more than one-half of this area is cleared and in farms, a large part being woodland or rough, wooded pastures.

In the eastern part of the county, in East Earl and Salisbury Townships, is another area of Chester soils, lying on the top and slopes of Welsh Mountain. The stony loam is here the prevailing type, with smaller areas of Rough stony land and small isolated areas of loam and fine sandy loam. Less than half of this section is cleared and in farms, most of it being covered with timber growths.

In the northeast corner and northwest corner are two other areas of Chester soils, each occupying ridges or mountains and being made up mostly of stony loam and Rough stony land. The larger part of these areas is not cleared.

In general the Chester loam and the less steep or stony areas of the stony loam in this county are devoted to the general farm crops, corn, oats, wheat, and grass, with some tobacco. In the southern part of the county the yields are good, corn giving 60 to 75 bushels, wheat 20 to 30, oats 30 to 40, hay 1½ to 2 tons per acre. Tobacco also gives good returns. Land is here valued at \$60 to \$80 an acre. In the other areas the yields are not so satisfactory and the land is valued much lower. Some fruit is grown on the Chester area, especially on the stony loam. The results so far obtained would seem to warrant the extension of orchards on selected areas.

The stony loam areas bring from \$25 to \$60 an acre, depending on location and character of improvements.

Lebanon and Dauphin Counties.—The Chester soils occur in small areas in the southeast and southwest corners of Lebanon County. In Dauphin County there are two small areas in the southern townships. All these areas occupy ridges and have a hilly topography. The stony loam with some rough stony loam and some small bodies of the loam are the types found. Less than half the area is cleared, the larger proportion being too steep or stony for cultivation.

The general farm crops do quite well, and fruit, especially apples, very well on these soils. Land values vary greatly, depending on local conditions. The farmed areas bring from \$40 to \$60 or more an acre.

York County.—The slate loam, loam, and stony loam of the Chester series occur in York County. These soils are found east of the extensive belt of Manor soils, east (or southeast) of the York Valley. The loam is used advantageously for the production of general farm crops, tobacco, and Irish potatoes. The land must be well handled, however, in order to be kept in a productive condition. The slate loam and stony loam are less valuable than the loam, which in the best situations brings from \$75 to \$100 an acre.

MANOR SOILS.

The Manor series includes those soils having brown or yellowish-brown surface soils and light-yellow or reddish-yellow subsoils, that are derived from the weathering of mica schist, chloritic schist, and schistose gneiss. The soil mass contains varying quantities of fine mica flakes, and in and on the soil varying quantities of fragments of the parent rocks are usually found. In some places the content of mica flakes increases to such an extent that at depths of 2 to 4 feet the subsoil is a mass of loose mica particles.

The Manor series occupies country of rolling to hilly topography, with steep slopes along the streams and stony steep-sided ridges. The rocks from which these soils are derived vary in their resistance to weathering. Where the more resistant rocks occur, or where the more resistant and less resistant occur in alternating beds, the topography is more hilly and the stony type prevails. Where the weathering is more uniform the topography is more rolling and the loam type is developed.

Two types of the series, the loam and the stony loam, have been recognized in the present survey.

The surface soil of the Manor loam consists of 8 to 10 inches of yellowish-brown or brown fine, smooth loam, containing many finely divided flakes of mica. The subsoil consists of a yellow or reddish-yellow heavy loam or silty clay loam, containing a larger proportion

of fine mica as the depth increases, until at 3 feet or more the mass is frequently made up wholly of mica fragments.

The Manor stony loam consists of 6 to 8 inches of yellowish-brown to reddish-brown heavy loam, resting on a clay loam of yellow or reddish-yellow color. Both soil and subsoil contain from 30 to 60 per cent of flat angular rock fragments of varying size.

The soils are naturally well drained, the water percolating readily through the soil mass. In most cases the soils are likely to be droughty. This is especially true of those areas where the loose micaceous subsoil comes within the 3-foot section. The soils wash easily, and considerable damage from erosion occurs, especially on the steeper slopes.

The soils are used chiefly for the production of the general farm crops; corn, oats, wheat, rye, and grass are grown, with some potatoes, buckwheat, tobacco, and fruit.

Chester County.—In Chester County the Manor soils make up nearly one-fourth of the total area, extending across the county just south of the Chester Valley, in a belt 1 mile wide at the east and broadening out to about 4 miles opposite Coatesville, thence spreading out to cover the southwestern section of the county to the Maryland line. Two types are found, the stony loam occupying the steep slopes and the range of low hills just south of the Chester Valley and the loam occupying a more rolling to somewhat hilly country south of the stony loam area.

The largest part of the loam is in farms, but a large proportion of the stony loam is covered with forest. Land values range from \$20 to \$75 an acre, with \$45 to \$50 a fair average price. In the survey of Chester County in 1905 the average yields of the leading crops are reported as: Corn, 60 bushels; oats, 40 bushels; wheat, 22 bushels; potatoes, 125 bushels; and hay $1\frac{1}{2}$ tons per acre for the loam, and corn, 40 bushels; oats, 25 bushels; wheat, 15 bushels; potatoes, 75 bushels; and hay, 1 ton for the stony loam. Erosion is severe on the steeper slopes, and causes considerable damage in cultivated fields if not checked in its early stages.

Montgomery County.—In Montgomery County the Manor soils lie west of Conshohocken, between the Schuylkill River and the Chester County line. The soils occupy country of hilly topography. The stony loam makes up nearly the whole area, with a few small areas of the loam on lower slopes.

The soils are very similar to those in Chester County, the crop yields being somewhat lower, though land values are somewhat higher. This latter condition is due to the nearness of these areas to Philadelphia.

Lancaster County.—The Manor soils occupy a large part of southern Lancaster County, extending from the limestone valley and the hills of Mine Ridge south to within about 4 miles of the Maryland

line. The country is generally rolling to hilly, with steeper hills and more abrupt slopes along Pequea Creek on the northwest and Octoraro Creek on the east. The steeper areas are forested, but the more rolling country is largely cleared and in farms. The loam is the most extensive type, but large areas of stony loam exist.

Though inclined to be rather droughty, the soils are well adapted to the general farm crops. Corn gives 80 to 100 bushels; oats 30 to 40 bushels; wheat, 20 to 30 bushels; potatoes, 100 to 150 bushels; and hay, 1 to 1½ tons per acre. On the best farms the yields range higher than this. Land values vary considerably. Good land, with good improvements, is held at \$40 to \$60 an acre, but in the poorer sections the range is probably between \$25 and \$40 an acre.

The soils are deficient in lime and organic matter and are greatly benefited by applications of these materials.

York County.—The Manor series is represented in York County by the slate loam and silt loam. The former occupies a large area lying between the Chester and Berks belts. It is the most extensive soil in the county and is a well-drained type, with rolling to hilly topography. The smoother parts are used successfully for the production of the general farm crops, giving moderate yields where carefully cultivated. Corn, oats, wheat, and hay are the principal crops. Probably over 75 per cent of the type is under cultivation. Near railroads the price of this land ranges from \$50 to \$90 an acre, while in the more inaccessible sections from \$20 to \$50 is about the range in value. The silt loam occurs in small bodies. It is used for the same crops as the slate loam, and gives somewhat better yields.

PENN SOILS.

The Penn soils consist of brown,¹ reddish-brown or Indian-red surface soils resting on an Indian-red subsoil of heavier texture than the surface soil. The soils are derived from the weathering of the red sandstones and shales of Triassic age that occur throughout the Piedmont Plateau region.

The soils lie in an irregular belt extending from the Delaware River above Trenton, across Bucks, Montgomery, northern Chester, southern Berks, northern Lancaster, southern Lebanon and Dauphin, and northern York Counties, continuing beyond York County into Adams County, which was mapped in 1910 in the South-Central Survey. In addition to this belt there are several extensions and outlying areas of Penn soils in the counties named, with some small areas in Lehigh County.

The soils in general occupy gently rolling to moderately hilly country, though in some areas, notably in Berks County, erosion has so cut and dissected the Triassic deposits that the areas now have a

¹ The brown soils derived from light-colored Triassic rocks properly should be included in the Lansdale series.

steeply rolling to hilly topography. This character of topography is, however, unusual for the Penn soils.

Owing to their position the Penn soils usually do not suffer severely from erosion, but on the steeper slopes, and particularly on the slopes along the streams in the otherwise nearly level country, considerable sheet erosion and some gullying occurs.

The soils in general are imperfectly drained. They are derived from rocks that usually lie in a more or less horizontal position and this, with the heavier subsoils and generally level topography, prevents the ready removal of the waters that work down into the soil. Large areas of the silt loam and loam need artificial drainage before they can be put into the best condition for crop production.

Seven types have been recognized in the area—the stony loam, shale loam, gravelly sandy loam, sandy loam, loam, silt loam, and clay loam. Of these the loam and silt loam are the only types of extensive area.

The Penn stony loam consists of 8 to 10 inches of a brown, reddish-brown, or Indian-red loam ranging from rather sandy to rather silty in texture which rests on a dark brownish red or Indian-red silty clay loam or clay subsoil. Both soil and subsoil contain from 30 to 60 per cent of flaggy sandstone and shale fragments.

The Penn shale loam consists of dark-brown or brownish-red silty loam, grading at 8 to 10 inches into deep-red or Indian-red silty clay loam containing many shale fragments, and passing below into disintegrated shale rock within the 3-foot section.

The Penn gravelly sandy loam consists of about 10 inches of a reddish-brown or Indian-red gravelly sandy loam resting on a dark Indian-red gravelly loam or gravelly clay loam. The soil and subsoil contain from 25 to 60 per cent of gravel, consisting largely of small rounded quartz pebbles, derived from the conglomerate from which the soil was formed.

The surface soil of the Penn sandy loam is a dark-brown sandy loam 6 to 10 inches deep underlain by a brown or dark-red or Indian-red sandy loam to clay loam subsoil.

The Penn silt loam consists of Indian-red or reddish-brown silt loam, 8 to 12 inches deep, resting on Indian-red or reddish-brown silt loam grading into Indian-red silty clay loam at lower depths.

The surface soil of the Penn loam consists of about 10 inches of a reddish-brown to Indian-red loam of rather variable texture, resting on an Indian-red heavy loam to clay loam subsoil.

The Penn clay loam consists of 8 inches of a brownish-red or Indian-red clay loam or silty clay loam resting on a dark Indian red plastic clay.

The general farm crops of the region are grown on the Penn soils. The soils are productive, the loam and silt loam being ranked high as

agricultural soils. They are friable, comparatively free from stones, and easily worked.

Bucks County.—In Bucks County the Penn soils occur in a band about 3 miles wide extending across Hilltown, Bedminster, and Tinicum Townships, in areas north and west of Quakertown in the north of the county, and in others south and west of New Hope in the eastern part of the county. Smaller areas are found scattered over the central and western part of the county. The soils usually occupy gently rolling to steeply rolling country, but in the northern part of the county there are some steep slopes and rather hilly areas. The loam and silt loam are the most extensive types, with smaller areas of shale loam and a few spots of clay loam. The larger part of the area is in farms, though there are some rough, wooded areas of the shale loam in the northern part of the county. In some places the gradation between the brownish-red Penn soils and the lower lying Lansdale soils is so gradual that it is hard to determine the boundary between them. There are small areas of Penn in the Lansdale soils and of Lansdale in the Penn soils, that because of small size and similarity to the prevailing series, could not be separated and shown on the map.

The Penn soils in Bucks County are valued at \$50 to \$100 an acre, with \$75 an acre as a fair average price for the ordinary farm with good buildings and fences.

Crop yields vary considerably but ordinarily are about as follows: Corn 70 to 80 bushels, oats 35 bushels, wheat 20 bushels, potatoes 100 bushels, and hay 1½ tons per acre. Some buckwheat is grown.

A large proportion of the loam and silt loam soils need artificial drainage. Most of the Penn soils are low in lime, and organic matter is needed to a greater or less extent on every farm. With these needs supplied and with deeper plowing and thorough tillage the Penn soils may be made very productive.

Montgomery County.—The Penn soils occupy a large irregular area in the central part of Montgomery County, between Norristown, Ambler, Lansdale and Royersford. There are several scattered areas, of smaller size, east and north of this large body. The silt loam is the only type found in the county. It covers 19.5 per cent of the area of the county, or 61,824 acres. The following description is adapted from Mr. Wilder's report of the Montgomery County survey in 1905:

The topographic features of the Penn range from slightly rolling to steeply rolling, with most of the type moderately rolling. Erosion is active on the steeper slopes and along the streams. The drainage features vary widely. Where the texture of the underlying rock is such that it has weathered deeply and the soil has accumulated to considerable depths, drainage conditions are generally good. Where

the rock is of varying hardness and the soils are not deep, seepage areas are common along the slopes and poorly drained areas exist in the uplands. From one-fourth to one-third of the Penn area in the county would be benefited by artificial drainage.

The Penn silt loam is adapted to the general farm crops, corn, oats, wheat, and grass. Corn yields average about 100 bushels, wheat 20 bushels, oats 30 bushels, hay 1½ tons per acre.

Chester County.—In Chester County the Penn soils lie just south of the Schuylkill River in an irregular band, 2 to 6 miles wide, extending from Valley Forge northwest to the Berks County line. The Penn loam and Penn stony loam types are found, the latter being of small extent. The soils occupy a rolling to hilly country, and the surface is more broken than in most Penn areas.

Drainage is well established on the stony loam and over most of the loam, though small depressed areas exist which need to be drained artificially. On many of the ridges and on much of the stony loam the soils suffer from drought, being shallow and loose, and low in organic matter.

Owing to the steepness of the slopes, the soils are quite subject to damage from erosion, and gullies and washed places are common. Sheet erosion causes great damage, though its effect is not so apparent. Care should be taken to reduce or prevent the washing of the soils, either by contour plowing or, where necessary, by terracing.

The soils are well adapted to the general farm crops. The yields on the loam are as follows: Corn 100 bushels, oats 30 bushels, wheat 20 bushels, rye 25 bushels, hay 1½ tons, and potatoes 150 bushels per acre. Yields on the stony loam, where it is farmed, are much lower.

Berks County.—The Penn soils occupy the southern part of Berks County, lying in a large band south of a line drawn east and west through Reading. The soils occupy steeply rolling to hilly country, with many steep slopes and some areas approaching the mountainous. The topography is much rougher than in the other counties where these soils are found. A large part of the Penn soils, lying on the steeper slopes, is in forest or pasture. This is especially true of the stony loam, much of which is too rough for successful farming. Only about 25 per cent of the stony loam is cleared. The stony loam, gravelly sandy loam, shale loam, and loam are the most extensive types, with some small areas of clay lying in the shale loam and loam districts.

Most of the soils are well drained, the gravelly sandy loam and shale loam being so loose and porous that they suffer severely from drought. In dry seasons it is only by careful cultivation that sufficient moisture can be maintained to give good crop yields. Organic matter is usually deficient on these soils. The loam and clay loam have better water-retaining ability and make surer crops. Lime is in common use over the whole region, with excellent results.

Land values range from \$25 to \$50 an acre, depending on character of the land and the distance from markets. The yield of corn ranges from 40 to 80 bushels, wheat 15 to 25 bushels, oats 30 to 40 bushels, hay 1 to 2 tons, and potatoes from 75 to 150 bushels per acre. Some tobacco is grown on the Penn soils.

Lancaster, Lebanon, and Dauphin Counties.—The area of Penn soils in Berks County is continued into Lancaster County along the northeast border, extending in a large triangular area as far as Ephrata. An arm reaches west and south along the northern border of the county to the Susquehanna River. The same belt extends into southern Lebanon County, and in an irregular area across southern Dauphin County. In these counties the greater part of the Penn soils occupy steeply rolling to hilly areas, with some mountainous sections. In the western part of Lancaster and Lebanon and in Dauphin Counties the soils occupy a more rolling country, with considerable areas that are gently rolling or nearly level.

The loam, sandy loam, and stony loam are the important types, but smaller areas of other types are also found. The stony and sandy loam are the most extensive. Over the two types just mentioned drainage conditions are good, though there are a few depressed areas that could be improved by artificial drains. The sandy loam is often low in water-retaining capacity and crops are likely to suffer damage by drought. The loam as a whole is not well drained. Large areas north of Elizabethtown and east of Middletown are badly in need of artificial drains, and until these are put in maximum crops can not be obtained. In this region the need of lime is most apparent. The hillier areas suffer considerably from erosion, the sandy loam being quite subject to washing and gullying. Considerable losses are occasioned from these sources.

Land values vary considerably in the region. The rough, hilly sections are valued at less than \$25 an acre, while the price of areas suitable for farming ranges from \$25 to \$50 an acre, depending on location. The best areas of Penn soil are worth \$75 to \$100 an acre.

Crop yields vary widely, ranging from 80 to 120 bushels of corn, 15 to 30 bushels of wheat, 30 to 60 bushels of oats, 1 to 2 tons of hay per acre. Considerable tobacco is grown in these counties, and excellent returns are obtained where the crop is well handled.

York County.—The following members of the Penn series are found in York County: The shale loam, sandy loam, loam, gravelly loam, clay loam, silt loam, stony sandy loam, and gravelly sandy loam. These soils occur rather extensively on the west side of the York Valley. They are well drained, and are in general use for the production of the general farm crops. The yields are good on the heavier members, the loam, silt loam, and clay loam, and fair on the other types. Peaches, small fruits, and vegetables do especially well on the sandy loam, gravelly sandy loam, and stony sandy loam.

Land of the heavier types is held at \$35 to \$90 an acre, depending upon location, improvements, and condition of soil with respect to past treatment.

LANSDALE SOILS.¹

The Lansdale soils are closely related to the Penn soils, both in origin and in topographic position. They have brown to grayish-brown surface soils of 6 to 12 inches depth, with yellowish-brown subsoils, usually of clay loam texture, becoming heavier with depth. The soils are derived from the brownish sandstones and shales of Triassic age. Some of the areas mapped as Lansdale in this survey are in reality Lehigh and would be so shown in a detailed survey.

The soils form a large part of the area of Bucks and Montgomery Counties and occur in small areas in Berks, Lehigh, Chester, Lancaster, and York Counties. The large areas occupy gently rolling to moderately rolling country, with many almost level areas. The topography of smaller bodies is rolling to hilly and much more broken than typical and, in many cases, they are derived from Triassic sandstones and shales that have been metamorphosed.

Erosion is not severe on the soils, except on some of the small, hilly areas, but over most of the silt loam drainage is a serious factor. In Bucks and Montgomery Counties fully one-half of the Lansdale soil area must be artificially drained before maximum yields can be obtained.

Two types of the Lansdale series are found in the area surveyed, the silt loam and the stony loam. The latter is of very minor importance.

The stony loam consists of 8 inches of dark-brown or grayish-brown silty loam, resting on yellowish-brown silty clay loam, grading with depth into a clay loam. Both surface and subsoil contain a very large quantity of angular fragments of sandstone and shale, making cultivation difficult.

The Lansdale silt loam consists of 8 to 12 inches of brown to grayish-brown silt loam, resting on a heavy silt loam grading into a silty clay of a yellowish or grayish-yellow color, mottled where poorly drained.

The soils are used in the production of cereals, hay, potatoes, and tobacco.

Bucks County.—The Lansdale soils cover nearly one-half the area of Bucks County, occupying a broad belt across the county, broken by the large area of Penn soils near New Hope and by smaller areas of Penn scattered through the Lansdale belt. The soils occupy gently rolling country, with many level areas. Practically all the land is in farms and a very large proportion of it is tilled. With the exception of a few scattered areas of a lighter sandier soil and a few

¹ Includes some Lehigh soils.

small areas of stony loam in the northern part of the county, the silt loam occupies the entire Lansdale area.

The soils are devoted to the general farm crops, with considerable areas of pasture. Dairying is one of the leading farm industries. When in good condition the Lansdale soils yield well. Corn gives from 80 to 100 bushels, oats 30 to 35 bushels, wheat 20 to 25 bushels, hay 1 to 2 tons, and potatoes 150 bushels per acre. Good Lansdale silt loam is valued at about \$75 an acre, though the prices range from \$50 to \$100 an acre.

The soils in this county are naturally rather poorly drained and need lime.

Montgomery County.—A large area of Lansdale soils is found in the east-central part of Montgomery County and large disconnected areas in the southwestern and northern parts of the county. In the eastern and southern sections the areas have a gently rolling topography, but in the western and northern sections the topography is more broken, being rolling to hilly in places. The silt loam is the only type recognized by the detailed survey made in 1905, although a rather sandy phase of the type occurs in places along the Schuylkill River. In the Schuylkill County detailed survey, in 1909, a soil similar to this lighter phase was mapped as the Birdsboro silt loam—a river terrace soil.

The larger part of the Lansdale area is in farms, and most of it is tilled. Drainage conditions are fairly good, though in the eastern section, next to Bucks County, there are large areas that would be improved by the installation of tile drains. The soils are in need of lime and are greatly benefited by applications of organic manures.

General farm crops are grown, corn yielding 100 bushels, wheat 22 bushels, oats 35 bushels, potatoes 100 bushels, and hay 1½ tons per acre. Land values vary from \$60 to \$100 an acre, with \$75 a fair average.

Chester County.—The Lansdale silt loam occurs in a few small areas south and west of Phoenixville in Chester County. These have a gently to moderately rolling topography, and are fairly well drained. The soils are devoted to the general farm crops, good yields being obtained.

Berks County.—The Lansdale soils occupy small scattered areas in the southern and southeastern parts of Berks County. Two types were recognized—the silt loam and the stony loam. The soils occur in rolling to hilly country and are normally well drained. The stony loam is inclined to be somewhat droughty. Land values vary greatly, but are lower than the general average for these soils. Crop yields are somewhat lower than in Montgomery County. Corn yields on the average 45 bushels, oats 30, wheat 18, and hay 1 ton per acre.

Lancaster County.—In Lancaster County the Lansdale soils occur in three areas, two in the east near the Berks County line and one in

the west north of Manheim. The two eastern areas have hilly topography and are largely stony loam, while the other area is composed of silt loam and a rather shaly phase of that type.

The eastern areas are largely in forest, while the western area is practically all in farms. General farm crops are grown, with fair yields. The soils are well drained, and are inclined to be droughty. They have a low organic matter content, and are, as a rule, in need of lime.

Lehigh County.—The Lansdale soils occupy a small total area in Lehigh County, being found in the southern part near the Bucks County line. The stony loam is the most extensive type but is not farmed, being largely in forest. The other types, aggregating less than 2 square miles in area, are farmed and give fairly good yields. The silt loam is the most productive, yielding 35 to 60 bushels of corn, 30 to 50 bushels of oats, 15 to 25 bushels of wheat, and 1 to $1\frac{1}{2}$ tons of hay per acre. This land is valued at \$50 to \$60 an acre.

York County.—The following Lansdale soils are found in York County: The sandy loam, loam, fine sandy loam, silt loam, stony loam, and gravelly loam. These types occur in association with the Penn soils. The loams and sandy loams have a crop adaptation and value very nearly the same as the corresponding members of the Penn series. The fine sandy loam, silt loam, stony loam, and gravelly loam, on the other hand, are comparatively poor soils.¹ They probably give the best results when used in the production of grass and small grains.

CECIL SOILS.

The Cecil soils were mapped only in a few isolated areas in Montgomery, Chester, and York Counties. The soils here are derived from igneous rocks, largely syenite, diorite, and gabbro. They occupy rolling to hilly country. The surface soils are generally a reddish-brown color with a red silty clay subsoil. Only a small portion of the Cecil area is farmed, most of it being in pasture or in forest.

Montgomery and Chester Counties.—In Montgomery County the clay loam and stony loam types were found, while in Chester County the Cecil clay was the only type. Because of their small area and topographic position the soils are of relatively little importance.

York County.—There are a number of Cecil clay loam and stony loam areas in the southeastern part of York County. The former is used for about the same crops and has about the same value as the Chester loam. The stony loam is less valuable, both on account of its rougher topography and its stony character.

¹ These four types are really members of another series, the Lehigh, which was not recognized in the reconnaissance survey. They are grayish to slate-colored soils derived from metamorphosed Triassic rocks.

CARDIFF SOILS.

The Cardiff soils were found in one small area in southwestern Lancaster County and in small areas in York County. The soil consists of a fine silty loam or heavy loam of a gray, ashy, or drab color, resting on a subsoil of light-colored or mottled silty clay loam or clay. A considerable quantity of flat slate fragments occurs on the surface, the proportion increasing in the subsoil until it grades into broken slate at depths less than 3 feet. The soils occupy the tops and slopes of narrow slate ridges, and in most places the areas are steeply inclined. The soil is fairly well drained. Where the soil is shallow, crops suffer from droughts.

Lancaster County.—In the one small area in Lancaster County the soils occupy the steep slopes adjacent to the Susquehanna, and only a small proportion of the land is farmed. General farm crops are grown with fair yields.

York County.—A small area of Cardiff slate loam occurs in the southeastern part of York County. Most of this is cultivated. Wheat, oats, and corn do fairly well.

CONOWINGO SOILS.

The Conowingo soils are derived from the weathering of serpentine, granite, and other crystalline rocks. The color of the surface varies from gray to drab. The subsoil consists of a grayish-yellow, rather mottled, silty clay loam or silty clay. The soils are encountered in northern Lancaster County, in Chester County, and in Delaware County.

The soils occupy rough, narrow ridges and roughly rolling hills and are of little agricultural value except in Delaware County. There are two types of Conowingo soils encountered in this survey—the barrens and the clay.

The barrens consist of a shallow silty surface soil, resting on broken or on hard unweathered rock. The soils are very compact, and because of the position of the underlying rock have poor drainage.

The clay consists of a grayish-brown or bluish-gray silty clay loam or heavy silt loam, resting on a light grayish yellow silty clay loam or silty clay. The underlying rock is usually within 20 to 30 inches of the surface.

Chester and Lancaster Counties.—In Chester and Lancaster Counties the Conowingo barrens make up a large part of the area of the Conowingo soils. They are of little agricultural value. Some pastureage is obtained, and in a few places the soil is farmed, and some crops are obtained in favorable seasons. The most common growth is stunted cedars and scrub oaks.

The clay is also found in these two counties, but not over half of the total area is suitable for farming, most of it being in pasture or in woods.

Delaware County.—Some Conowingo clay is found in Delaware County. The best area noted lies west of Media where there are several quite productive farms on this soil. The soil is very much in need of lime, that material being almost necessary before a successful crop can be secured.

When well drained, limed, and manured, the Conowingo clay will give fair yields of the staple crops. Corn, oats, wheat, and potatoes are grown, with a large proportion of the area in grass.

UPLAND GLACIAL SOILS.

VOLUSIA SOILS.

The Volusia soils are derived from the feeble glaciation of the sandstone and shales that form the bedrock of an extensive region in northeastern United States, the soil mass being made up partly of residual material weathered from the underlying rock, but mainly from this same rock material which has been picked up, mixed, ground, transferred a short distance, and redeposited by the ice as a thin till sheet. Where the underlying rock was a shale or fine-grained sandstone the resulting soil material is usually fine textured, a silt loam or loam, but where the underlying rock was a hard sandstone or conglomerate, as is the case over most of the area included in this survey, the soils formed are loams, stony loams, sandy loams, and Rough stony land. In contrast to these till deposits are the sandy and gravelly materials forming the moraines that mark a halting place of the glacier front. These morainic deposits are not extensive in the area covered by this survey.

The Volusia soils have gray or grayish-brown surface soils with gray, grayish-yellow, yellow, or mottled heavy subsoils. The soils are often underlain by an impervious stratum, locally known as hardpan, giving very poor drainage conditions.

The topographic position of the Volusia soils varies considerably, depending on the character of the underlying rock. In Columbia County, in Luzerne County, north of the Susquehanna River, and in an area between Wapwallopen and Glen Summit, and in Monroe County between Pocono and Blue or Kittatinny Mountains, the Volusia soils occupy a steeply rolling to hilly country that consists of a succession of rounded and often flat-topped hills and uplands separated by deep V-shaped, steep-sided valleys. Viewed in a broad way, these regions occupy broad lowland belts with steep mountain ranges on each side of them. Because of the great width, the true character of the country is not readily apparent in northern Luzerne County.

Over northern Monroe and Carbon Counties, a corner of southern Luzerne, and also the northwestern corner of Luzerne County the Volusia soils occupy the sides and tops of the mountain ridges and plateaus. In these regions the underlying rock is a hard sandstone, and the ice did little more than stir up and move the weathered fragments. The soils are shallow and stony and often seem almost wholly residual in character. In most places, however, there is a thin sheet of glacial till and a readily apparent disturbance and alteration of the rocks and boulders, some bearing distinct glacial scratches. In places, in the valleys and on the plateaus, the till and morainic deposits have partly filled drainage basins, damming the streams and forming lakes, some of considerable size.

The Volusia soils are generally poorly drained. The compact, impervious subsoil prevents the free downward movement of the soil water and holds it in the soil mass, making the soils cold and wet. On the slopes the water that soaks in at higher levels comes to the surface in seepage areas as "wet weather springs," and in some places forms swampy or marshy strips. In the mountain region the drainage is better than in the regions that can be farmed.

Five types in the Volusia soils—the stony loam, sandy loam, silt loam, loam, and clay loam—were found in the present survey. In addition to these there are large areas of Rough stony land, undifferentiated as to texture of fine-earth material.

The surface soil of the Volusia stony loam consists of 6 to 8 inches of gray or dark-colored heavy loam resting on yellow or mottled silty clay loam. The soil and subsoil contain from 40 to 60 per cent of stone fragments of varying sizes.

The surface soil of the sandy loam consists of 6 to 8 inches of friable, rather silty, brownish sandy loam, resting on a lighter colored, yellowish silty clay loam or silty loam, in places rather sandy.

The silt loam consists of 6 to 8 inches of gray or brownish-gray silt loam, resting on a gray or yellow silty clay loam that grades into a mottled silty clay.

The Volusia loam consists of 6 to 8 inches of grayish-brown or dark-brown rather silty loam resting on yellowish or mottled silty clay loam grading to a mottled clay.

The Volusia clay loam consists of 6 to 8 inches of grayish-brown silty clay loam resting on a gray, yellow, or mottled clay loam or clay subsoil.

Of the types adapted to agricultural use, the silt loam is by far the most extensive. The loam and clay loam occupy a comparatively small total acreage, occurring in small scattered areas over the Volusia region. The sandy loam is of considerable extent, but it is a rather shallow soil, very deficient in organic matter, and usually not productive. Considerable areas are found on the plateau tops, where

stones are numerous, and where the soils are isolated from markets and shipping points.

The Volusia soils are adapted to general farming crops, being especially adapted to the growing of grasses. Dairying is one of the leading farm industries, and fruit growing and trucking are followed to some extent.

Luzerne County.—The Volusia soils cover all of Luzerne County, except the southwest section, the terminal moraine crossing the county from above Nescopeck through Freeland to the southeastern corner, where the county line strikes the Lehigh River. The general topography of this region has already been described. Fully half of the Volusia area lies on the flanks of the mountain ranges and on the eroded plateau tops. In these positions it is of little value for agriculture, though in the plateau section there are many cleared areas, each comprising one or more farms. These are situated where the till deposit is comparatively thick, and are usually of the silt loam or loam type. Southwest of White Haven is a considerable area that is farmed. Here the loam is most extensive, with some sandy loam on the morainic deposits.

In the valleys of the Big and Little Wapwallopen Creeks are well-developed farming sections, given chiefly to the production of the general farm crops, with some truck and fruit. The silt loam is the most extensive type and the topography is rather hilly.

Beyond the range of hills just north of the Susquehanna River lies the most extensive development of Volusia soils suitable for farming. All of this region, except the northwest corner, which is mountainous, consists of undulating, steep-sided, low hills, with narrow V-shaped valleys. The silt loam type covers most of the region, with some stony loam, loam, and sandy loam. General farm crops are of first importance, with some trucking, and a large and increasing acreage devoted to fruit, mostly apples. Bush fruits and strawberries are grown to some extent, the small fruits and truck being marketed in Wilkes-Barre and the other towns in the anthracite coal region.

Considerable dairying is done, milk being sold in the towns in the vicinity, shipped to New York, or sold to the local creameries and skimming stations. Little wheat is grown in this region—in fact, but little wheat is grown in the county, rye taking the place of wheat in the rotation whenever a winter grain is grown at all.

The soils are not well drained and are in need of lime and additions of organic matter. With these deficiencies supplied, good returns can be secured.

Land values vary, the rough mountain lands being worth less than \$1 an acre, while in the agricultural sections the land brings from \$25 to \$50 an acre.

Columbia County.—The Volusia soils in Columbia County occupy a strip of country from 4 to 6 miles wide along the eastern boundary. The terminal moraine enters the county about 2 miles north of Berwick, extends west nearly to Orangeville, along the foot of Lee and Knob Mountain, turns back along Knob Mountain, crossing it and extending north along Fishing Creek, about one-half mile east of the creek. The moraine crosses Fishing Creek above Benton and swings northwest, leaving the county west of Divide. With the exception of the mountains east of Orangeville and the mountains along the north boundary of the county, all of the county covered by the Volusia is farming land, though there are extensive wooded areas, especially on the steeper slopes and in the more hilly regions. The topography is generally hilly, with narrow, steep-sided valleys.

The silt loam is the most extensive type, with a smaller area of the loam and stony loam. General farm crops are grown. Potatoes are grown as a special crop to some extent. Fruit trees are being set out, but the interest is not so keen as in Luzerne County. In general the crop yields are fair, and land values are about the same as in Luzerne County. The region lacks transportation facilities, the only railroad being located along Fishing Creek, in the valley 200 or more feet below most of the Volusia soils.

Carbon County.—In Carbon County the Volusia soils have little or no agricultural value, the areas lying on the eroded mountain plateau in the northern part of the county. The soils are generally Rough stony land and stony loam and are largely cut-over land. A few cleared areas are used for growing some of the general farm crops. Usually the loam and silt loam are found in such areas.

Monroe County.—In Monroe County the Volusia soils occupy three-fourths of the county, covering all except the five southwest townships. The northern half of the county is generally rough, including the Pocono Mountain plateau and ridges. South of the Pocono Mountain, between it and the Kittatinny Mountain the Volusia soils occupy a hilly, ridged valley. Here the soils are devoted to general farming, with some fruit and truck growing on areas near Stroudsburg and the summer resorts. The general farm crops do quite well. Corn averages 40 bushels, oats 35 bushels, rye 18 bushels, hay $1\frac{1}{2}$ tons, and potatoes 100 bushels per acre. Little wheat is grown. Land values vary considerably, ranging from \$25 to \$65 an acre. Including the woodland and rough land on a farm, the average value per acre would be about \$35 or \$40. Usually not over two-thirds of the total farm acreage can be tilled.

The soils are badly in need of lime and are low in organic matter. Lime and manure will materially increase crops. Green manuring must be practiced, as the farm manures are not sufficient to supply the needs of the soil. Drainage conditions are often poor.

Northampton County.—In Northampton County the only Volusia soils that exist are the Rough stony land areas on Kittatinny Mountain. The Volusia soils are of no agricultural value in this county.

LACKAWANNA SOILS.

The Lackawanna series includes those soils having light-red to dark Indian red soils and reddish-brown to dark-red subsoils and derived from the feeble glaciation of red shales and sandstones. These soils are developed to a considerable extent north of the present area, in the region covered by the reconnaissance survey of 1911. In the present survey they occupy a few small, scattered areas in Columbia, Luzerne, Monroe, and Carbon Counties.

The soils are found where the glaciation of the red rocks of the Catskill formation was so feeble and the till sheet so thin that the soil mass is made up largely of residual material, reworked to some extent and mixed with a small proportion of foreign material. The areas have a rather rough topography, occurring on hilltops or on steep slopes along the valleys. Not more than half of the area of these soils is in farms, most of it being in forest or in cut-over brushy lands. The soils are usually well drained, though there are some wet areas. In this area the shale loam is most extensive, though there are some areas of stony loam and loam. The latter gives fair yields of the general farm crops where it is well tilled. The soils are badly in need of lime in most places.

Columbia County.—In Columbia County these Lackawanna soils occur in small areas in Sugar Loaf, Fishing Creek, Briar Creek, and Center Townships. The topography is hilly, with some rolling uplands. The soils are devoted to the general farm crops, with fair returns. Potatoes are grown to some extent, and in the northern areas rye is grown to the exclusion of wheat. Land prices vary, ranging between \$30 and \$50 an acre.

Luzerne County.—In Luzerne County there are small areas in Lake, Nescopeck, Huntington, and Foster Townships. Nearly all occupy hill slopes, and are mostly the shale loam and stony loam types. Where farmed they are devoted to the general crops of the region—corn, oats, wheat, rye, buckwheat, potatoes, and grass. Yields are fair, usually somewhat better than on the Volusia soils that surround them.

Monroe County.—In Monroe County the Lackawanna soils occur in several scattered areas, the largest one lying in Jackson and Pocono Townships. The soils occupy hilly country and are essentially the same as those in Columbia and Luzerne Counties. Land values range from \$15 to \$45 an acre. General farm crops are grown.

Carbon County.—There is just one small area of Lackawanna soil in Carbon County. This occupies a steep slope opposite Lehigh Tannery and is of little agricultural value.

DUTCHESS SOILS.

The Dutchess soils are derived from the glaciation of the shales and shaly sandstones that normally give the Berks soils, and are made up partly of glacial till and partly of the weathered shale material, the former usually forming the larger part of the surface soil, and the latter, especially in the loam and shale loam types, most of the subsoil.

The soils typically have a yellowish-brown or grayish-brown surface soil, from 6 to 10 inches deep, with a yellow, grayish-yellow, or yellowish-brown silty clay or clay loam subsoil, usually containing considerable shale fragments and grading into loose broken shale at from 2 to 4 feet.

Besides the Rough stony land, three types were encountered —the stony loam, loam, and shale loam.

Northampton County.—The Dutchess soils occupy the eastern end of Northampton County, extending from the Blue Mountain south to Belvidere and from the Delaware River west to a line through Mount Pleasant, Ackermanville, and North Bangor. They cover all of Upper Mount Bethel and part of Washington and Lower Mount Bethel Townships.

The whole area of Dutchess soils is covered with waterworn and glacially scratched stones and boulders. Near the mountain the stones are so numerous as to make cultivation impracticable, the soil being a mass of stones of various sizes, with very little fine earth. Farther south the stone content decreases until near the southern boundary it is a negligible factor in cultivation.

The areas have a rolling to somewhat hilly topography. They are subject to considerable erosion, and washes and gullies are common on the hillsides. Normally they are well drained, though some, where the glacial till is quite deep, are inclined to be wet. These are usually the more stony areas.

The stony loam is largely in forest and pasture; and other types are generally farmed. The general farm crops are grown. Corn yields 35 to 60 bushels, oats 25 to 50 bushels, wheat 15 to 25 bushels, potatoes 100 to 200 bushels, and hay 1 to $1\frac{1}{2}$ tons per acre. The soils need lime and organic matter. Land prices vary, depending on type and location. The rough stony soils are worth less than \$5 an acre, while the loam and shale loam range from \$50 to \$75 an acre.

COASTAL PLAIN SOILS.

The Coastal Plain occupies but a small area in Pennsylvania, occurring as a strip from 3 to 5 miles wide along the Delaware River in the counties of Delaware, Philadelphia, and Bucks.

The soils of this division are mapped as Sassafras, but include some Elsinboro, Meadow, Tidal marsh, and Madeland. There are also a few areas of Elkton and of Portsmouth soils that are too small to be shown on a map of the scale used.

SASSAFRAS SOILS.¹

The Sassafras soils are derived from the weathering of unconsolidated sediments of late geological age. The types have brown or yellowish-brown surface soils with yellowish-brown, yellow or reddish-yellow subsoils. The soil mass has usually considerable depth, but on the inner edge, next to the Chester soils of the Piedmont Plateau, the rock lies less than 3 feet below the surface. In these latter areas the soils are often stony and contain more mica than is typical, though the type normally contains considerable quantities of this mineral. Fine quartz gravel is also a feature of the type, and in a few places the gravel content is large.

The soils occur in Delaware, Philadelphia, and Bucks Counties, lying as a strip from 2 to 8 miles wide between the Piedmont Plateau and the Delaware River. The soils lie almost wholly below the 200-foot contour, and occupy the gently sloping surfaces of low, eroded terraces. From the Piedmont Hills, which rise 100 to 150 feet above the inner edge of the Coastal Plains, the Sassafras soils look flat and level, but on driving over them the surface is found to be gently rolling, with a general southeastern inclination and some steep slopes along the stream cuts. On the latter the underlying rock is usually exposed. Along the Delaware River there is a strip representing a low terrace (probably an estuarine terrace) of nearly level to slightly sloping surface. This terrace begins in Delaware County, crosses Philadelphia County, and enters Bucks County.

The soils are fairly well drained, especially south of Philadelphia. North of that city there are considerable areas of the silt loam and fine sandy loam, which as mapped are poorly drained,² drainage in some areas being very deficient.

Four types of this series were found—the fine sand, fine sandy loam, sandy loam, and silt loam.

The fine sand consists of a brownish-yellow fine sand resting on a subsoil of similar texture. The soil mass to a depth of 3 feet is quite uniform, though the subsoil is usually lighter colored than the surface and is often somewhat reddish where the soil is most open and porous.

The Sassafras fine sandy loam consists of a brown or yellowish-brown fine sandy loam, underlain at about 8 inches by yellowish to reddish-yellow silty loam to fine sandy clay loam. Both soil and subsoil contain a small quantity of fine quartz gravel and finely divided mica. Coarse material is frequently present in the lower subsoil or substratum.

The Sassafras sandy loam consists of a light-brown or yellowish gritty sandy loam, with a depth of 10 inches, resting on a yellow to

¹As mapped includes some areas of Elsinboro soils.

²Some of the poorly drained areas in a detailed survey would doubtless have been mapped as Elkton.

yellowish-brown silty sandy loam or loam becoming heavier with depth. Both soil and subsoil contain mica flakes and fine gravel. In places the latter is found in considerable quantities.

The Sassafras silt loam consists of a yellowish-brown to brown silt loam, 5 to 10 inches deep, resting on a yellowish or mottled yellow, brown and reddish silt loam to silty clay loam. The soil mass contains a considerable amount of very finely divided mica, giving it frequently a smooth feel. In places the soil, as mapped, is poorly drained.¹

Although the soils are well adapted to trucking, they are almost wholly devoted to general farming and dairying.

Delaware and Philadelphia Counties.—In Delaware and Philadelphia Counties the Sassafras soils occupy a belt 3 or 6 miles wide, lying between the Delaware River and the edge of the Piedmont. The inner border reaches an elevation of 150 to 200 feet, extending as a series of rather indistinct terraces and rolling slopes, practically to tide level. Much of the area is fine sandy loam. Areas of the silt loam lie in the more nearly level country. The sandy loam occurs in small scattered areas. About one-half of the Sassafras soils is in farms, the remaining area lying in and near the many boroughs and cities.

In these counties much of the land is occupied by business and manufacturing plants, but there are extensive market gardens, both north and south of Philadelphia. Here the most intensive farming is practiced, with liberal use of manure and fertilizers. The acreage value of most of these gardens is very high, as nearly all are located where they will ultimately be used for residential or manufacturing purposes.

In Ridley and Darby Townships of Delaware County the land values are very high, being used for building lots or held by real estate operators for future development. The same is true along the Delaware River in Chester and Lower Chichester Townships. Where the land is held at its farming valuation, \$150 to \$200 an acre is asked. In Philadelphia County land values are high, based on the future development of the city rather than on agricultural value. Prices range from \$300 to \$400 an acre upward, depending on location.

Throughout the whole area of the Sassafras soils they are in need of organic matter. The success of the market gardens shows the results when this need is supplied. The soils are benefited by the use of lime, and the heavier types used need extensive underdrainage to make them of value.

Over one-half of the farms on the Sassafras soils are operated by tenants, in many cases the farms being owned by real estate operators who aim ultimately to subdivide the property. These tenanted

¹Some of the poorly drained areas in a detailed survey would doubtless have been mapped as Elkton.

farms are not receiving the treatment or tillage needed, and as a result the crop-producing value of the land is decreasing. It is doubtful if the Sassafras soils in this county will improve much from a farming standpoint. The extension of trolley and railroad facilities will cause a further development along suburban and manufacturing and a decrease in agricultural use.

Bucks County.—In Bucks County the Sassafras soils spread out into a belt between 5 and 8 miles in width, occupying the territory between the Delaware River and the Piedmont boundary. The soils occupy gently rolling to almost level areas, sloping toward the southeast, and lie between 40 and 150 feet above sea level. The area is almost wholly in farms, with a few patches of woodland. Over half of the silt loam area is poorly drained and most of this type and also the fine sandy loam areas need lime. The soils are generally somewhat deficient in organic matter, and in order to get the best results manure or green crops must be worked into the soil. Plowing is generally done to depths of 4 to 5 inches, though the character of the soil would warrant plowing to depths of 8 or 10 inches.

The Sassafras soils are devoted almost exclusively to general farming and dairying, with some trucking near the railways. Corn, oats, potatoes, wheat, and grass are grown. Some alfalfa is grown, and does well where the drainage is good and plenty of lime has been applied. Crop yields are fairly good. Corn yields 50 to 75 bushels, oats 30 to 40, wheat 20 to 30, potatoes 75 to 150 bushels, and hay from three-fourths to 1½ tons per acre. On the best-managed farms the yields are much higher than those stated for the area as a whole. Fertilizers and manures are used to a considerable extent, the latter being purchased in Philadelphia and shipped to local railway stations. Land values vary with location, soil conditions, and buildings, and range from \$50 or \$75 up to \$150 to \$200 an acre. From \$100 to \$125 is the general range in price of farm lands with fair improvements. Nearer the river the price is higher—\$200 or more an acre.

The dairies with few exceptions sell whole milk, shipping it to Philadelphia or New York, or selling to dealers who supply the near-by towns and cities. The soils are well adapted to intensive dairying, giving good yields of clover and other forage crops and of corn, either for grain or for the silo. Grasses generally "run out" quickly, and short rotations should be followed, though with proper fertilization and treatment permanent pastures may be maintained fairly well on the heavier areas of the silt loam.

TERRACE SOILS.

Four series—the Chenango, Wheeling, Holston, and Birdsboro—include the terrace soils found in this survey. They occupy the benches or terraces along the larger streams and are usually above

all but the highest overflows. They represent the alluvial deposits of the streams when they flowed at a much higher level than at present.

Of the four series, the Chenango is found in the glaciated region, and is formed largely from glacial materials. The Wheeling lies outside the glaciated region, but only along the large streams that flow from that region, and is composed of a mixture of the glaciated material with material derived from areas of residual soils. The Holston soils are derived mainly from sandstone and shale soils, while the Birdsboro are derived largely from Appalachian, Limestone Valley, and Piedmont materials.

CHENANGO SOILS.

The Chenango types have yellowish-brown to reddish-brown surface soils and yellowish-brown to brown subsoils. The subsoils of the heavier types, where not well drained, are dark grayish, or occasionally mottled.¹ The soils occupy benches and terraces in the glacial region and are most typically developed along the Susquehanna and Delaware Rivers, with some smaller areas along Broadhead, Pocono, McMichael, Fishing, and other creeks.

The soils generally have a level surface, though some of the higher terraces have been cut by erosion and now have a rolling topography. The soils are normally well drained, there being, usually, a permeable bed of gravel or rounded stones and small boulders in the deeper subsoil. The heavier types, which usually lie next the uplands, are sometimes kept wet by seepage water from the higher lying soils and in some cases are marshy or swampy. The soils, except in rare instances, are not subject to erosion.

Four types were encountered, the sandy loam, fine sandy loam, silt loam, and gravelly loam.

The Chenango sandy loam consists of 8 to 10 inches of brown to dark-brown sandy loam resting on a yellowish-brown or reddish-brown heavier sandy loam, grading into sand or gravel at 30 inches or deeper.

The Chenango fine sandy loam consists of 7 to 12 inches of reddish or yellowish-brown fine sandy loam resting on a compact fine sandy loam, lighter in color than the surface soil, and resting, at from 3 to 6 feet, on a bed of coarse sand and gravel.

The Chenango silt loam consists of 8 to 10 inches of dark-brown silt loam containing fine sand, resting on brown or yellowish-brown compact silt loam, becoming more sandy with depth and grading into sandy loam or sand at 36 inches or more below the surface.

The gravelly loam is variable in its texture, ranging from a sandy loam to a silt loam, with lighter subsoils. It is marked by the high

¹ These poorly drained terrace soils with heavy subsoils made up of sandstone and shale material are Holston soils occurring as small areas among the Chenango soils.

content of gravel and is often unsuitable for farming because of the large stone content and its droughty nature.

The Chenango soils are best adapted to market-garden, and truck crops, potatoes, and corn. Gardening is developed near the cities, but much of the land lies too far from the markets to permit this use.

Luzerne County.—The Chenango soils are found in Luzerne County along the Susquehanna River, along Huntington Creek, and in Butler Township along Nescopeck Creek. The soils have usually a level surface, though some irregular, eroded areas are found along the river in Salem and Nescopeck Townships, between Berwick, Nescopeck, and Wapwallopen. These latter areas are in farms, devoted mainly to corn, wheat, and grass production, with some potatoes and some truck. Yields are high where the organic-matter content is maintained. The fine sandy loam and silt loam types are most extensive.

Along the river from Nanticoke to Pittston are extensive areas of Chenango soils, occupying level or gently sloping benches. These are occupied to a large extent by mining towns, coal yards, and breakers, and by heaps of waste from the mines. Where the soils can be farmed they are giving excellent results with truck and garden crops. The soils along Nescopeck and Huntington Creeks occur as narrow level terraces and are devoted to the general farm crops and to pasture. All the soils along the Susquehanna are deficient in organic matter, and crops suffer severely during droughty seasons. Increasing the amount of organic matter in the soil and more thorough tillage will cause the soils to hold water better and will materially increase their productiveness.

Columbia County.—In Columbia County the Chenango soils occur along the Susquehanna River and Fishing Creek. The areas along the latter stream are small and have a nearly level surface. The soil has been modified somewhat by material from the red Catskill rocks and in places is redder than the typical soils of the series. The areas are devoted to general farming and are very productive. They are valued at \$60 to \$75 an acre.

Along the Susquehanna the high Chenango terraces have been cut by erosion and have a variable topography, ranging from nearly level to rolling or hillocky. On the slopes the gravelly substratum, when exposed, gives a very gravelly soil. The soils are all in farms. General farming is the rule, but a little market gardening and truck growing is practiced. Where the organic-matter content is maintained the yields are high. Corn, potatoes, wheat, clover, and the grasses do very well, and alfalfa has been very successful where the soil has been properly prepared. Inoculation is nearly always necessary, and a liberal amount of lime must be applied in order to insure a stand. The soils are valued at \$75 to \$125 an acre. With the excellent trans-

portation facilities in this valley, trucking could well be extended on these soils.

Monroe County.—In Monroe County the Chenango soils are found along the Delaware River, along Broadhead, Pocono, and McMichael Creeks, and in detached areas along several smaller streams. The soils occupy level or gently sloping terraces and are nearly all in farms. General farming is the leading industry, with some market gardening near the larger towns. Nearly every farmer does some gardening, the many summer hotels creating an excellent local demand for vegetables. Corn, wheat, buckwheat, and hay are the leading general farming crops. Potatoes are extensively grown. The soils are well drained. They are usually deficient in organic matter and lime. The value of these soils varies widely, depending on location and transportation facilities.

Northampton County.—The Chenango soils in Northampton County are found along the Delaware River and Jacoby Creek. Near Portland the soils are stony and underlain by a deep deposit of gravel, and are excessively drained and droughty. The largest area lies east of Martin Creek, and has a level to gently sloping surface and good drainage. The sandy loam and fine sandy loam types are the most extensive, but some gravelly or stony areas are found. The soils here are devoted to general farm crops, of which excellent yields are obtained. Potatoes do well, yielding from 100 to 200 bushels per acre. Alfalfa does well where the land is properly prepared. The soils are deficient in organic matter, and in most cases need lime. Market-garden and truck crops do well, and their production could very profitably be extended. The land is valued at \$75 to \$150 an acre.

WHEELING SOILS.

The Wheeling soils are found on level to sloping terraces along the Susquehanna and Delaware Rivers. The surface soils are yellow to brown, and the subsoils, which are generally lighter colored than the surface, yellow to bluish gray. In a few places the surface and subsoil are tinged with red, owing to a mixture of red material from the Upshur regions, but this is not typical. The soils are made up of material transported from the residual sandstone and shale regions, mixed with an appreciable amount of glacial material similar to that forming the Chenango soils. The gravel substratum underlying the Chenango is rarely found in the Wheeling soils, but there is much more gravel and rounded stone present than in the Holston soils. The Wheeling soils were formed when the streams normally carried much more water than they now carry and flowed many feet above their present level. The soils are thus the deposits laid down by swiftly flowing streams heavily charged with sediment.

The soils are most extensively developed along the north and west branches of the Susquehanna in Northumberland and Montour Counties, and along the Susquehanna in Dauphin and Lancaster Counties. Smaller areas border the Delaware River in Bucks County.

The soils normally occur on level or gently sloping terraces, but in places these terraces have been eroded and now exist as rounded slopes and low flat-topped hills. The soils usually have good natural drainage, though there are a few areas of clay loam and silt loam that are poorly drained. These usually lie back from the present stream, next to the hills, and are kept wet by the seepage and surface flow from the higher lying lands.

Several types of the series are found in the present survey; the fine sand, fine sandy loam, and silt loam have the greatest extent, with the sand, sandy loam, loam, and clay loam less important.

The surface soil of the Wheeling fine sand consists of yellowish-brown somewhat loamy fine sand, 10 to 15 inches deep. The subsoil is a yellow fine sand.

The Wheeling fine sandy loam consists of 8 to 10 inches of yellowish-brown to brown fine sandy loam, resting on a lighter brown fine sandy loam that grades in some places into a compact yellow fine sand.

The Wheeling silt loam consists of 6 to 8 inches of brown mellow silt loam, resting on a yellowish-brown to bluish-gray or mottled, compact silt loam, which may grade into a silty clay loam within the 3-foot section.

The Wheeling clay loam consists of a heavy, dark-colored clay loam resting on a yellowish or bluish-gray mottled clay loam or clay. This type usually has poor drainage.

Nearly the whole area of Wheeling soils is in farms. General farming is the prevailing type of agriculture, though the soils are well adapted to truck and garden crops, and in some sections to fruit.

Northumberland and Montour Counties.—The Wheeling soils reach their greatest development in Northumberland and Montour Counties. The areas along the North Branch near Danville and at the junction of the North and West Branches at Northumberland and Sunbury are occupied to a large extent by cities, manufacturing plants, and railroad yards, though some market gardening, trucking, and general farming is carried on. North of Montour Mountain to beyond the Lycoming County line the Wheeling soils are very extensively developed. Over most of this area they are devoted to general farming with corn, potatoes, wheat, and hay the leading crops. Crop yields are high, and the farms and buildings are in excellent condition. The soils are usually well handled, but in some cases are low in organic matter. Near Montandon considerable trucking is done, the fine sand and fine sandy loam soils being preferred for

the purpose. Truck and garden crops find a ready sale in the towns along the river, and the business is quite profitable.

The area of Wheeling soils extending from Dewart east beyond Turbutville is not as good as those just mentioned. The soil is mostly loam and silt loam, and crop yields are about two-thirds as large as upon the soils along the river. In this region are found areas of clay loam, usually poorly drained, and adapted mainly to use in growing grasses and as pasture.

Over a large part of the Wheeling area the soils need lime, and nearly all would be benefited by increasing the content of organic matter. The land varies much in price, the best farms near markets being held at \$200 or more an acre. The ordinary range is from \$75 to \$150 an acre.

Dauphin County.—In Dauphin County the largest development of the Wheeling soils occurs along the Susquehanna from Fort Hunter southward to the county line.¹ This area of soil varies from one-half mile to 2 miles in width and occupies a series of terraces, the higher ones being eroded and rounded; the lower more nearly level. The soils are mostly sandy, fine sandy loam and sandy loam being the more extensive types. The areas are all farmed, and a great deal of market gardening is being done. Sweet corn, potatoes, cabbage, peas, beans, celery, sweet potatoes, melons, etc., are grown, together with strawberries, raspberries, and other fruits. The truck finds a ready market in Harrisburg, Steelton, and the other local towns, very little being shipped to more distant markets. The general farm crops are grown over most of these Wheeling soils, corn, tobacco, wheat, potatoes, and hay being the leading crops. The yields are very good and land values high, \$100 to \$200 or more an acre. Smaller areas of Wheeling soils occur also near Dauphin, Speeceville, Halifax, Millersburg, and Paxton. These are usually devoted to general farming and are held at \$65 to \$100 an acre. All the Wheeling soils need organic matter and the addition of lime would improve many areas.

Lancaster County.—In Lancaster County the Wheeling soils occur as an extension of the area in Dauphin County, and have the same general characteristics. The soils occupy a strip about one-half mile wide extending from Falmouth to Marietta and smaller areas at Columbia and Washingtonboro. The soils are prevailingly sandy, and are well adapted to garden and truck crops. They are now devoted almost wholly to the production of general farm crops, corn, wheat, tobacco, potatoes, and hay, of which good yields are obtained. The soils are well drained, but are deficient in organic matter.

York County.—The Wheeling silt loam occurs along the Susquehanna in York County. The areas are comparatively small. It is a

¹ Mapped as Donegal gravelly loam in Lebanon Survey, 1901.

variable soil, producing excellent yields of corn, small grains, grass, and clover.

Bucks County.—The Wheeling soils in Bucks County occur along the Delaware as narrow, level terraces, lying well above the highest overflows. The soils are prevailingly sandy, the fine sandy loam and loam being the more extensive types. They are well adapted to trucking, but are now devoted to general farming, giving good yields of the standard crops. Land of these soils is valued at \$60 to \$100 an acre. The soils are deficient in organic matter, and the loam and heavier types usually need lime.

HOLSTON SOILS.

The Holston soils are not extensively developed in this survey, being found only in small areas in Schuylkill, Lebanon, Lehigh, Northampton, and York Counties. The soils occur as second bottoms and terraces along the larger streams, and lie above all but the highest overflows. They represent the deposits made when the streams flowed at higher levels than they do at the present time. The surface soils are grayish yellow to dark grayish brown in color with yellow, gray, or mottled subsoils. Drainage conditions vary greatly. The lighter types are normally well drained, but the heavier often need artificial drainage. Several types were encountered, the silt loam being of greatest extent.

The Holston silt loam consists of 6 to 8 inches of gray to grayish-brown silt loam, resting on a yellow to mottled silty clay loam, grading with depth into a mottled silty clay. The other types encountered included fine sandy loam, loam, clay loam, and clay, and occurred in very small areas.

Schuylkill and Lebanon Counties.—Along the Swatara Creek in Schuylkill and Lebanon Counties the Holston soils are developed as a narrow, level to sloping terrace on each side of the narrow bottom lands. The bottoms could not be shown and are mapped with the Holston. The soils are devoted to the general farm crops and to pasture, corn, wheat, and the grasses giving the best results. Several small areas of Holston soils occupy level to sloping terraces along the Schuylkill River. Most of the towns in this part of the State are located on these terraces. Where available for farming the general crops are grown. There are also a few small gardens and truck farms.

Lehigh and Northampton Counties.—In Lehigh and Northampton Counties there are small areas of Holston soils along the Lehigh River and its tributaries. Some truck and garden crops are grown, but the soils are generally utilized for the general farm crops—corn, wheat, and hay. The yields are moderate to large. The soils along the Lehigh River are better drained than elsewhere.

York County.—In York County the Holston soils are found along several of the larger streams, but they are nowhere extensively developed. They are utilized for pasture or general farm crops.

BIRDSBORO SOILS.

The soils of the Birdsboro series are yellowish brown to brown and the subsoils yellow to yellowish brown. Occasionally water-rounded stones are scattered over the surface and mixed with the soil. The soils consist of alluvial or water-worked material, a great part of which is derived from Appalachian, Limestone, and Piedmont materials. They have been mapped only in the Piedmont section of the State. The topography is nearly flat to gently rolling and the drainage is good. The soils are fairly well suited to general farming.

Berks County.—The silt loam of the series has been mapped in Berks County. It consists of yellowish-brown silt loam, with an average depth of 10 inches, resting on a yellow or yellowish-brown silty clay loam. Both surface soil and subsoil contain some rounded stone and gravel. The soil occurs along the Schuylkill River below Reading, occupying a somewhat eroded terrace, and has a rounded sloping surface. The natural drainage is good. The soil is fairly good for general farming and is very good for trucking. Good yields of corn, small grains, and hay are obtained. The growing of truck and garden crops could profitably be extended on this soil.

BOTTOM-LAND SOILS.

The bottom lands in this survey have been divided into four series, and the miscellaneous type Meadow. The Genesee and Barbour series are found in the glaciated region, and the Huntington and Schuylkill series in the region south of the terminal moraine. The soils all occupy first bottoms and are subject to periodic overflow. Where these overflows occur only in winter or early spring, the land can be safely cropped, but where they may occur after any heavy rain, as is often the case along the smaller streams, it can be used only for pastures or mowings. There are narrow strips of bottom lands along nearly every stream in the survey, but only a few of these areas were large enough to be shown on a map of the scale used in the reconnaissance survey.

GENESEE SOILS.

The Genesee soils include the first-bottom or overflow lands along the streams in the glaciated region. The soil mass is made up of the wash from the glacial soils, transported and redeposited by the action of the flood waters of the streams. They have yellowish-brown to dark-brown surface soils with lighter colored subsoils. They occupy level or gently sloping lands along the stream channels, and vary

greatly in drainage conditions. Most of the larger areas are well drained, but the long narrow strips are usually kept wet by water seeping from the higher levels. The soils are found all along the streams in the glaciated region, but are extensive only along the Susquehanna River and along Huntington Creek.

Luzerne and Columbia Counties.—From Pittston to Nanticoke, in Luzerne County, the Genesee soils occupy broad bottoms, locally called the Wilkes-Barre flats. The soils are inundated only by the highest floods, and seldom if ever, are overflowed during the growing season. The soils occupy level "flats" and are fairly well drained. The sandy loam and the silt loam are the chief types. They are very well adapted to truck and garden crops. Considerable trucking is being done, the produce finding a ready market in many mining towns and in Wilkes-Barre and the other near-by cities. The soils give excellent yields of the general farm crops, corn yielding 70 to 100 bushels, wheat 20 to 30 bushels, potatoes 100 to 200 bushels, and hay 1½ to 2 tons per acre. The soils are valued at \$100 to \$200 an acre, with higher values for the best truck farms.

Farther down the river at Wapwallopen, Nescopeck, Berwick, and Bloomsburg, in Luzerne and Columbia Counties, there are other areas of Genesee soils, quite similar to those just described. At Bloomsburg there is a considerable development of trucking, but the other areas are largely devoted to general farming. The latter areas are valued at \$75 to \$150 an acre, while the area near Bloomsburg ranges from \$100 to \$200 an acre.

The area along Huntington Creek, in Luzerne and Columbia Counties, is narrow and not well drained, the silt loam being most extensive. The soils here are best adapted to grass and pasture and, where free from danger of summer overflow, give good yields of corn and small grain.

Monroe County.—There are a few small areas along the larger streams and along the Delaware River in Monroe County. The soils are largely devoted to grass and pasture, with some areas in general farming and truck crops.

BARBOUR SOILS.

The Barbour soils include the first-bottom soils in the glaciated region, having red, yellowish-red, or pinkish surface soils and light-red or dark-red subsoils. They are formed from material transported from the Lackawanna soils—a series derived from the red shales and sandstones of the Catskill formation. The soils vary in texture, ranging from a sandy to a clay loam or clay, and though subject to periodic overflow, are generally in farms.

Columbia County.—The soils are found in small areas along several of the streams in the survey, but were extensive enough to be mapped

only along Fishing Creek in Columbia County, where they occupy a more or less continuous bottom extending from Bloomsburg to Jamison City. The soils are well adapted to the general farm crops. Potatoes yield 100 to 200 bushels, corn 70 to 90 bushels, oats 40 bushels, wheat 20 to 30 bushels, and hay 1 to 2 tons per acre. Poorly drained areas are utilized for pasture or mowing land. The soils are valued at \$60 to \$100 or more an acre. The soils are greatly benefited by additions of organic matter, and all the heavier types need lime.

HUNTINGTON SOILS.

The Huntington series includes the bottom lands in the region of residual soils. The types of this series have usually a brown to yellowish-brown soil with a yellow, gray, or mottled subsoil. The soils are composed of material washed from the sandstone and shale regions and their formation is still going on. The soils are found in narrow strips bordering nearly all of the streams in the region. The most extensive areas mapped lie along the Susquehanna River, with smaller areas on the Delaware, Schuylkill, and Lehigh Rivers, and along the larger creeks. Many areas are too small to be shown on the accompanying map. The soils vary widely, ranging from sands to clays, with the sandy loam and silt loam the important types.

Along the larger streams the Huntington areas are well drained, but in the areas near the smaller streams drainage is usually poor. In any case they are subject to annual overflow, and along the streams rising in the mountains may be flooded many times each year. Where the danger of floods is great and where drainage is poor, the soils are best used for the production of grass for pasturage and hay. Where well drained they give good yields of corn, potatoes, oats, wheat, and truck crops. The Huntington soils vary greatly in value. Extensive areas that are well drained are worth from \$75 to \$150 an acre. Many areas are held at less than \$50 an acre.

SCHUYLKILL SOILS.

The Schuylkill soils are found along the streams that flow out from the mining sections, and are classified separately because of the presence of varying amounts of fine coal dust, washed out from the breakers and culm banks.

The soils have a brown to black surface, with a yellow, gray, mottled, or black subsoil, the color depending on the amount of coal waste in the soil mass. In places near the mines the bottoms are deeply covered with coal particles. In such places all vegetation is killed, and the bottoms are desolate wastes. Several such areas occur along the Shamokin and Lykens Creeks, and along the Schuylkill and Lehigh Rivers and their tributaries. These areas could not be

separated from the soils that are partly made up of coal waste, but are still useful for crop production, and all were classed together as the Schuylkill soils. The soils are subject to periodic overflow, and drainage conditions vary greatly. They are adapted to the general farm crops, to grass, and to truck and garden crops. Where the admixture of coal waste is not great the soils are very productive, being much like the better areas of Huntington soils.

COLLUVIAL SOILS.

LICKDALE SOILS.

The Lickdale soils consist of colluvial wash, chiefly from sandstone and slate soils of the Appalachian Mountains and Ridges. They occupy slopes and flat areas near the foot of mountains and are poorly drained. The surface material is characteristically gray and the subsoil gray or mottled gray and yellow. The agricultural value is low. The soils are best suited in their natural condition to grass and pasturage.

Two types of the series are shown on the map, the clay loam and silty clay loam. The former consists of 6 to 10 inches of dark-gray clay loam of relatively high silt content resting on a mottled yellow, and neutral gray or bluish-gray heavy silty clay loam or silty clay.

The silty clay loam is composed of a dark-gray or dark bluish gray silty clay loam underlain at 8 to 12 inches by mottled gray and yellow fine sandy clay or stiff, plastic, silty clay.

Bucks County.—Areas of the Lickdale clay loam too small to map lie along the foot of the mountains in different parts of the area. A body of considerable size is shown near Quakertown and another smaller area in the vicinity of Brick Tavern. The areas are poorly drained, and in their natural condition suited only to the production of grass for pasturage, which is of relatively little value. When drained, the land will produce fair yields of hay, corn, oats, and wheat.

Dauphin and Lebanon Counties.—Several areas of the clay loam of sufficient size to map occur in Dauphin and Lebanon Counties. The conditions and crop possibilities do not differ greatly from those affecting the type in Bucks County.

York County.—The Lickdale silty clay loam occurs in small areas on the slopes of South Mountain, in York County. The material consists of colluvial wash from the slopes of South Mountain. The land is poorly drained and is best suited to grass. With better drainage and liming, corn and small grains could be successfully grown.

MISCELLANEOUS SOILS.

MEADOW.

Along many of the streams in the survey occur narrow strips of poorly drained soils, which vary greatly in color and texture and in agricultural condition. These soils were classed together as Meadow and, where their extent was sufficient, shown as such on the map. The soils are usually suited to the production of grass, but are seldom sufficiently well drained for growing cultivated crops. They afford good pasture and in places give good yields of hay.

Along the Delaware River from Philadelphia to Eddystone, is a considerable area of low, wet ground that has been classed as Meadow. Part of this is subject to overflow during high tide, and is really Tidal marsh. Other areas, particularly in the lower end of the peninsula between the Delaware and Schuylkill Rivers, has been filled in with material dredged from the river channels and now lies well above the highest tides. League Island has been built up in this manner. None of this land is adapted to agricultural use.

ROUGH STONY LAND.

Rough stony land includes areas which, on account of roughness of surface, due to the presence of rock fragments, rock outcrop, and steepness of slope, can not be cultivated, and is therefore of little or no value for agricultural purposes.

*York County.*¹—Rough stony land is mapped only in York County. The land represents extreme stoniness or roughness of several different stony soil types and is regarded simply as the nonarable portions of these types, not differing to any extent in the character of the soil material. Such land is produced under several different topographic and geologic conditions. The areas occupy mountainous ridges and steep slopes where disintegration and decomposition of the rock have not kept pace with erosion, precipitous river and creek bluffs, and a few areas which, although occupying gentle slopes, are strewn with such large boulders that the land can not be plowed. Practically all of the Rough stony land of York County is forested and brings in a small income from timber, fuel, and pasturage, although the grazing is, on the whole, scant.

Several large areas of Rough stony land occur on the diabase knobs or mountains in the northern part of the county. The land here represents extremely rough and stony phases of the Montalto stony loam and stony clay loam. The soil supports a thick growth and large

¹ Rough stony land is shown by separate color only in York County. It occurs, however, in other parts of the survey and has been indicated roughly by hatching. Some good farming land is included in the hatched areas also.

variety of hardwoods, which under proper management can be made a continuous source of income from the timber and fuel which they yield. Even on this very rough land small patches of one-half acre to an acre have been cleared and placed in strawberries and raspberries.

There is a considerable area of nonarable land on South Mountain, in the northwestern corner of the county. The land here is covered with very large angular blocks of quartzite and there are also precipitous slopes almost bare of soil covering. The mountain is forested mainly with chestnut.

Several areas of Rough stony land were mapped in the Conewago Mountains, where it is associated with the Penn stony sandy loam.

The river bluffs and very steep hillsides along Susquehanna River also form in the aggregate a large area of nonarable land. The upper slopes of the bluffs are nonarable on account of their steepness, though in addition the soil covering is very thin, and the lower or colluvial slopes on account of the presence of huge rock fragments which have rolled down from higher levels.

Rough stony land is at present valued at \$3 to \$10 an acre, depending mainly upon the character of the timber growth.

MUCK.

In the glaciated sections of the survey there are many small bodies of swampy land. Nearly all of these have been formed by the ponding of water, caused by the blocking of former drainage channels by the accumulation of glacial débris. Many of these areas, formerly lakes and ponds, have become filled with the accumulation of organic matter and sediment, and are now swampy beds of Muck. When these are drained they make excellent soils for celery, onions, cabbage, spinach, and similar crops.

Luzerne and York Counties.—In this area these Muck areas are all small and have been shown on the map only in Luzerne and York Counties, though there are areas, too small to indicate on the map, in Carbon and Monroe Counties. A few small areas have been drained and cultivated, but most of them are still in their original swampy condition. Their value is rarely appreciated by the farmer who owns them. Often, if drained and the truck crops grown, they prove more profitable than all the rest of the farm.

SUMMARY.

The area surveyed includes 19 counties of southeastern Pennsylvania and covers a total area of 10,254 square miles, or 6,562,560 acres.

The topography is varied, including the sloping terraces of the Coastal Plain, the rolling Piedmont Plateau Region, the level to

gentle rolling lowland belts of limestone, surrounded by narrow sandstone ridges of the Appalachian Mountains and the high mountains and elevated valleys of the Appalachian Mountains and Allegheny Plateau. The northern and northeastern sections have been glaciated.

The region surveyed is rather densely populated and comprises some of the oldest farm lands in the United States. Transportation facilities are well developed and the markets are excellent. Coal is the leading natural product, with clay products, slate, and limestone of considerable importance.

Climatic conditions vary from the marine type in the southeastern part to the mountain type in the central and northern parts. The average rainfall is about 43 inches, and the growing season relatively long.

General farm crops—corn, oats, wheat, and grass—are the leading products throughout the entire area, while dairying is the principal farm industry. Potatoes are extensively grown in Chester, Berks, Lehigh, Lancaster, and York Counties. Tobacco is a leading product in Lancaster and York Counties. Buckwheat is grown rather extensively in the northern counties, and throughout the whole region the production of apples is increasing.

Land values are relatively low, the range—excluding Philadelphia County—varying from \$12.59 in Monroe County to \$160.85 in Delaware County. The general average for agricultural lands would be about \$60 an acre.

The area covers a wide range of soils, 33 series being recognized. The Dekalb soils are the most extensive in the area and include the gray and yellowish soils derived from sandstone and shales. The Upshur soils include the red soils from the sandstone and shales and are found only in the northern portion of the area. The Berks series, derived from weathering of shales, form a very important body of soils in the great valley and adjacent to the limestone valleys in York and Lancaster Counties. The Mountalto soils are derived from igneous and metamorphic rocks and make up one of the most important fruit-growing sections of the region. The Hagerstown soils form the greater part of the limestone valleys and are uniformly the most productive soils in the area. The Conestoga soils, also derived from limestone, are nearly as productive as the Hagerstown. The Franks-town soils, derived from limestone, usually occupy narrow ridges and have proved excellent for apples. The Athol soils are derived from a mixture of limestone and sandstone material and are of limited extent.

In the glaciated region the Volusia soils are the most extensive and include those soils having a gray and grayish-yellow color. They

are excellent grass soils and well adapted to dairying and stock-raising industries. The Lackawanna series includes the red glaciated soils, and the Dutchess those soils derived from the glaciation of soft thin-bedded shales. The two latter series are inextensive in this area.

A number of soil series were recognized in the Piedmont Plateau region. The Chester series is the most extensive and important here and is among the most highly developed group of soils in the area. The Manor soils are similar to the Chester, but somewhat less productive. They are marked by a very high mica content. The Penn and Lansdale soils are derived from weathered sandstone and shales, the Penn having a reddish color, the Lansdale a yellow or brown color. These soils are productive and have been highly developed, but in many cases need drainage. The Cecil, Cardiff, and Conowingo soils are all inextensive and of little value in this area.

The Sassafras soils, lying in the Coastal Plain, are found in Delaware, Philadelphia, and Bucks Counties, and, while partly farmed, are in general held for suburban development. They are excellent soils for trucking and market-gardening.

In the terrace lands four series are found—the Chenango, including the light-colored terrace soils derived from glacial material; the Wheeling, including the light-colored terrace soils derived from a mixture of glacial and nonglacial material; and the Holston and Birdsboro series, which occupy terraces along the streams flowing through residual sections.

In the bottom lands several series occur. The Genesee and Barbour are found along the streams in the glaciated region and the Huntington and Schuylkill in the nonglaciated regions. None of these are extensively developed within this survey.

In addition to the above series areas of Rough stony land, Meadow, and of Muck, the latter in the glaciated part of the survey, are shown on the map.



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